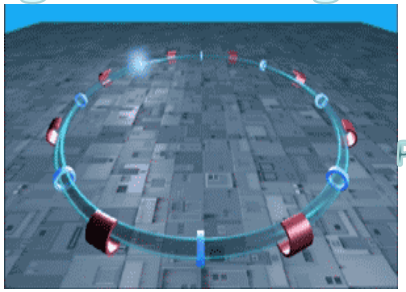
VIII Escola de Professores em Lingua Portuguesa



8th Portuguese Teachers School

CERN 2014

Bem Vindos

Introdução ao CERN e à Física de Altas Energias (HEP)

- A Organização
- O Laboratório
- Física de Altas Energias
- Os Aceleradores e as Experiências

Filme sobre o CERN (15 min)

Visita dos itinerários previstos (2h)

Isto e' uma "escola" portanto…perguntem!!
"Não há perguntas estúpidas"

História

1949

Primeira tentativa de cooperação civil em Física Nuclear

1952

Criação do
Conseil **E**uropéen pour la **R**echerche **N**ucléaire
sob os auspícios da UNESCO

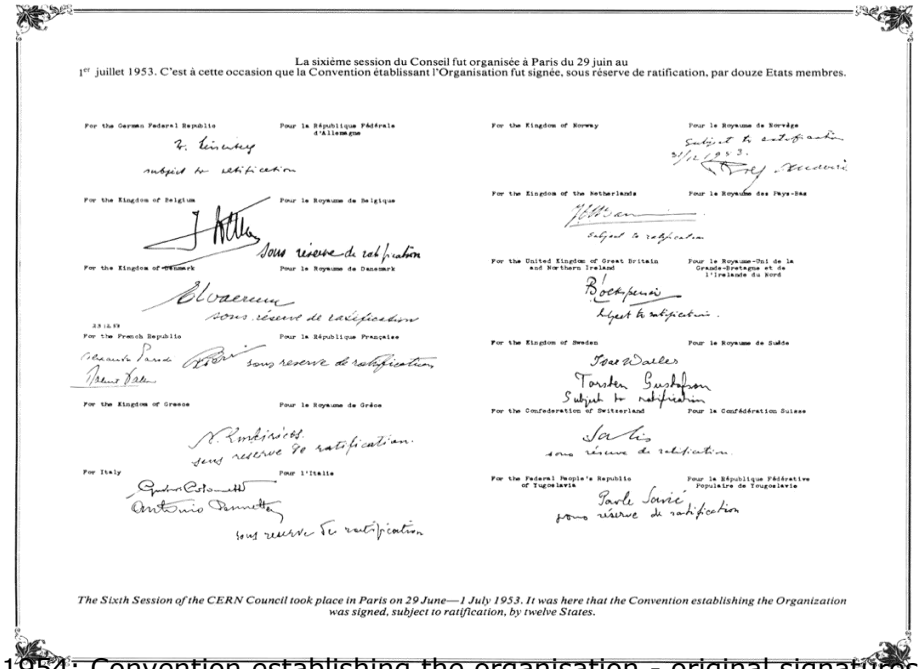
Outubro 1952

Escolha de Genebra para a localização do laboratório

Centro Europeu para Física de Partículas

CERN
European Organization for Nuclear Research

- Fundado em 1954 por 12 países Europeus
- 21 países membros
- Há cerca de 11000 utilizadores , dos quais 2300 são funcionários e cerca de 1000 subvencionados (2013)
- Orçamento anual de ~1000 Milhões Francos Suíços (2013) (~900 M.Euros)


La sixième session du Conseil fut organisée à Paris du 29 juin au 1er juillet 1953. C'est à cette occasion que la Convention établissant l'Organisation fut signée, sous réserve de ratification, par douze Etats membres.

For the German Federal Republic — Pour la République Fédérale d'Allemagne
subject to ratification

For the Kingdom of Belgium — Pour le Royaume de Belgique
sous réserve de ratification

For the Kingdom of Denmark — Pour le Royaume de Danemark
sous réserve de ratification

For the French Republic — Pour la République Française
sous réserve de ratification

For the Kingdom of Greece — Pour le Royaume de Grèce
sous réserve de ratification

For Italy — Pour l'Italie
sous réserve de ratification

For the Kingdom of Norway — Pour le Royaume de Norvège
Subject to ratification

For the Kingdom of the Netherlands — Pour le Royaume des Pays-Bas
Subject to ratification

For the United Kingdom of Great Britain and Northern Ireland — Pour le Royaume-Uni de la Grande-Bretagne et de l'Irlande du Nord
Subject to ratification

For the Kingdom of Sweden — Pour le Royaume de Suède
Subject to ratification

For the Confederation of Switzerland — Pour la Confédération Suisse
sous réserve de ratification

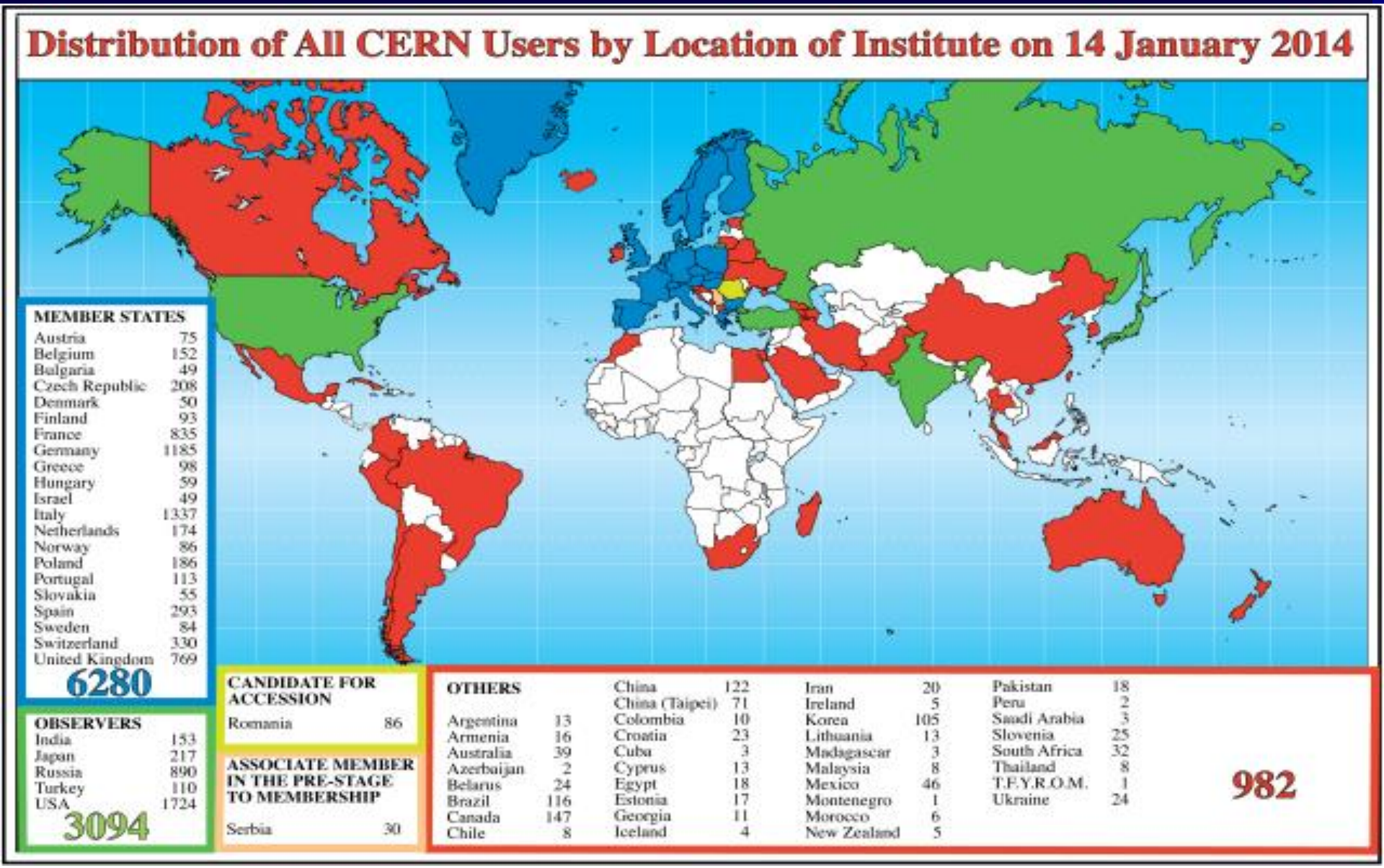
For the Federal People's Republic of Yugoslavia — Pour la République Fédérative Populaire de Yougoslavie
sous réserve de ratification

The Sixth Session of the CERN Council took place in Paris on 29 June—1 July 1953. It was here that the Convention establishing the Organization was signed, subject to ratification, by twelve States.

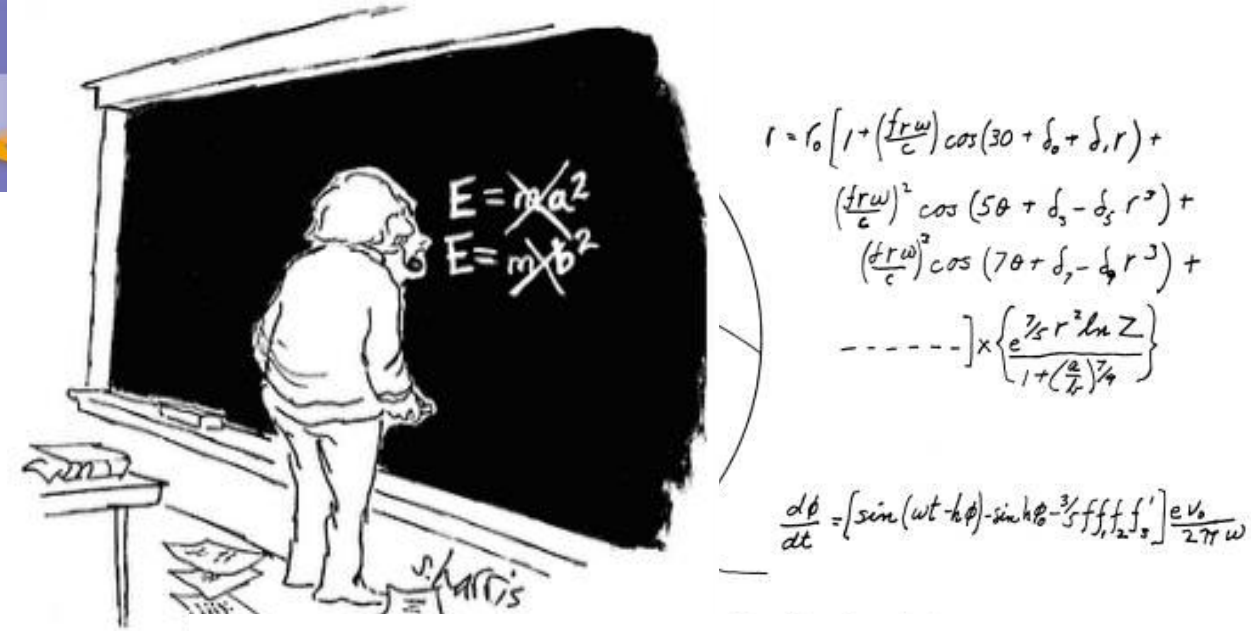
1954: Convention establishing the organisation - original signatures

2004: The 20 member states

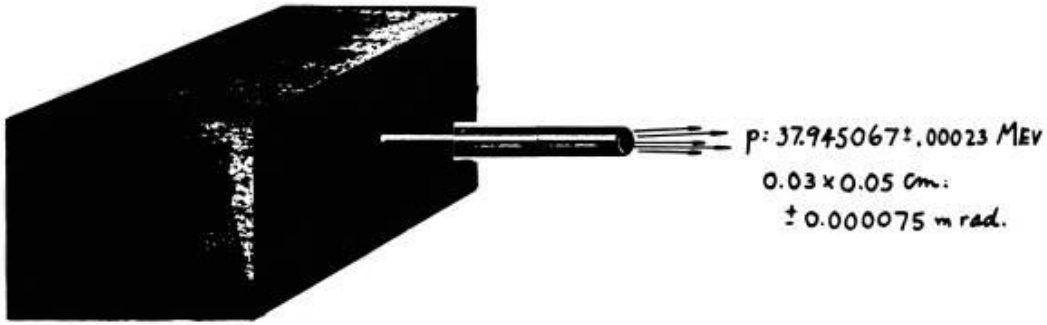
Distribuição dos Utilizadores do CERN por país (em 2014) ~11000 utilizadores



O CERN visto:
pelos media:

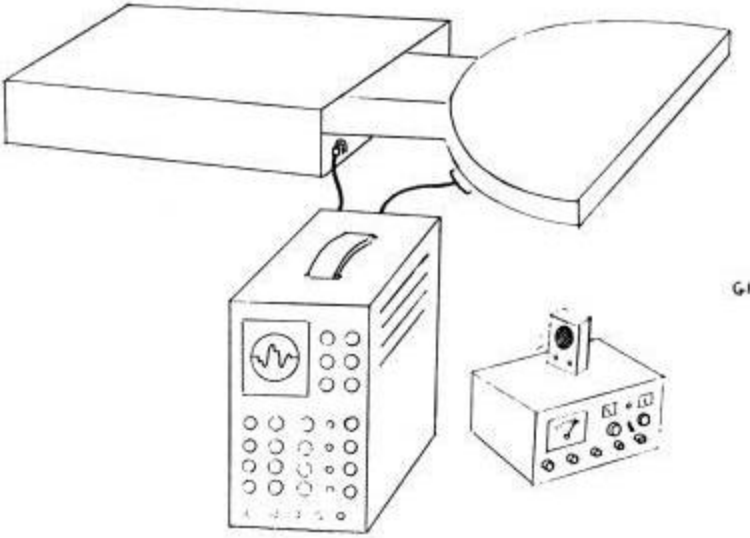


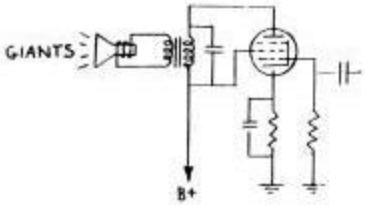
…físico teórico



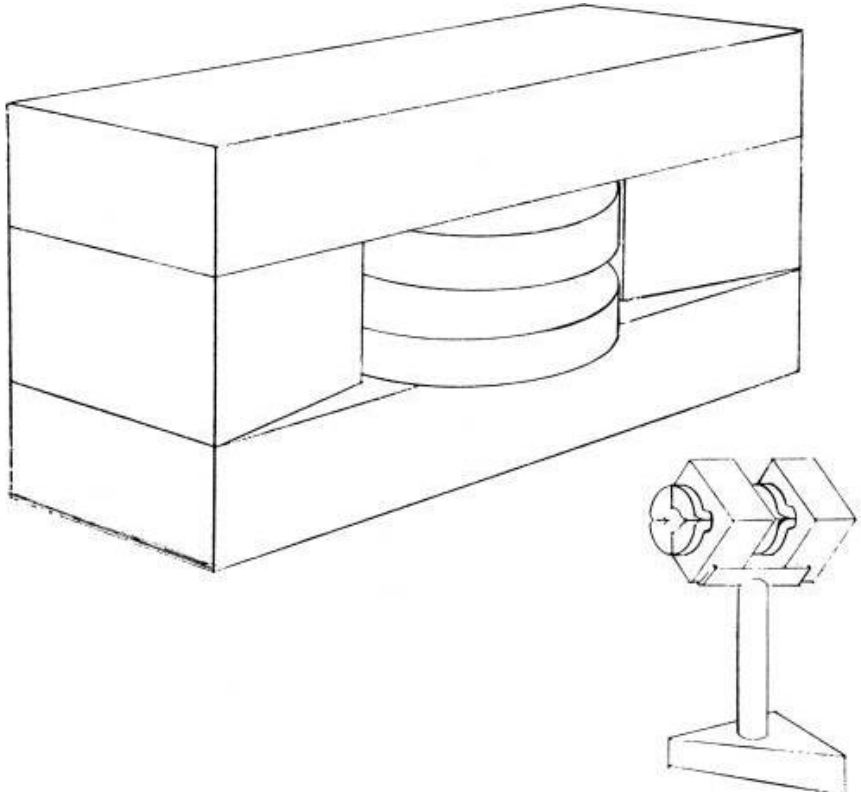
…físico experimental

XBD9705-02297.TIF

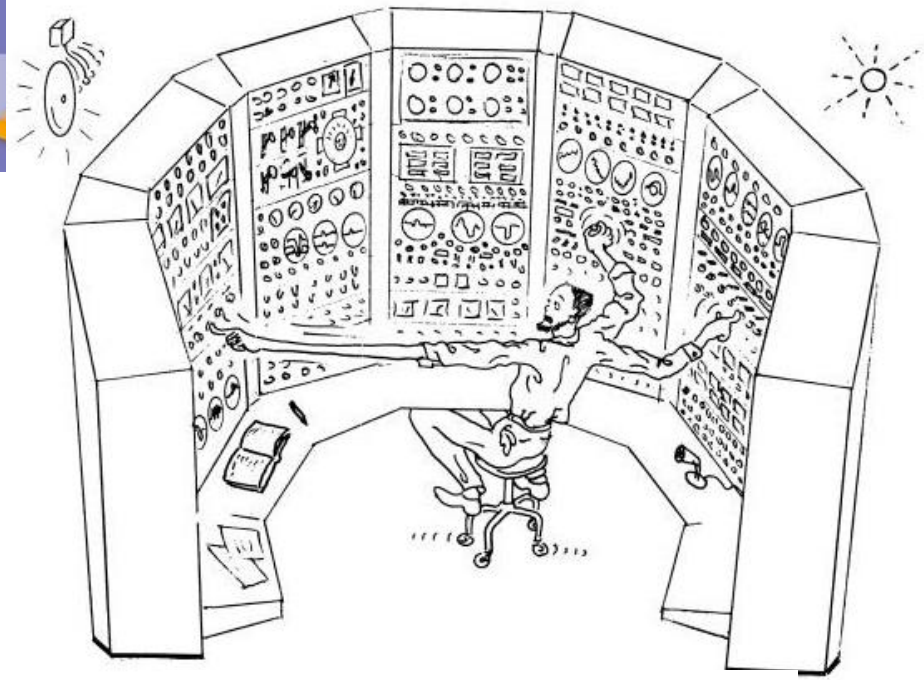




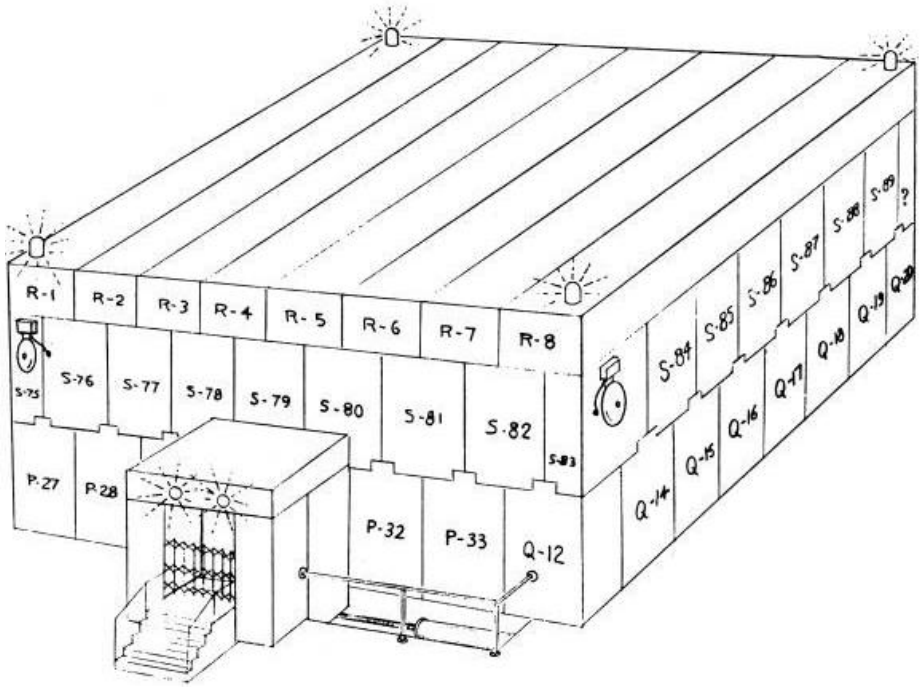
…Eng. Electrónica



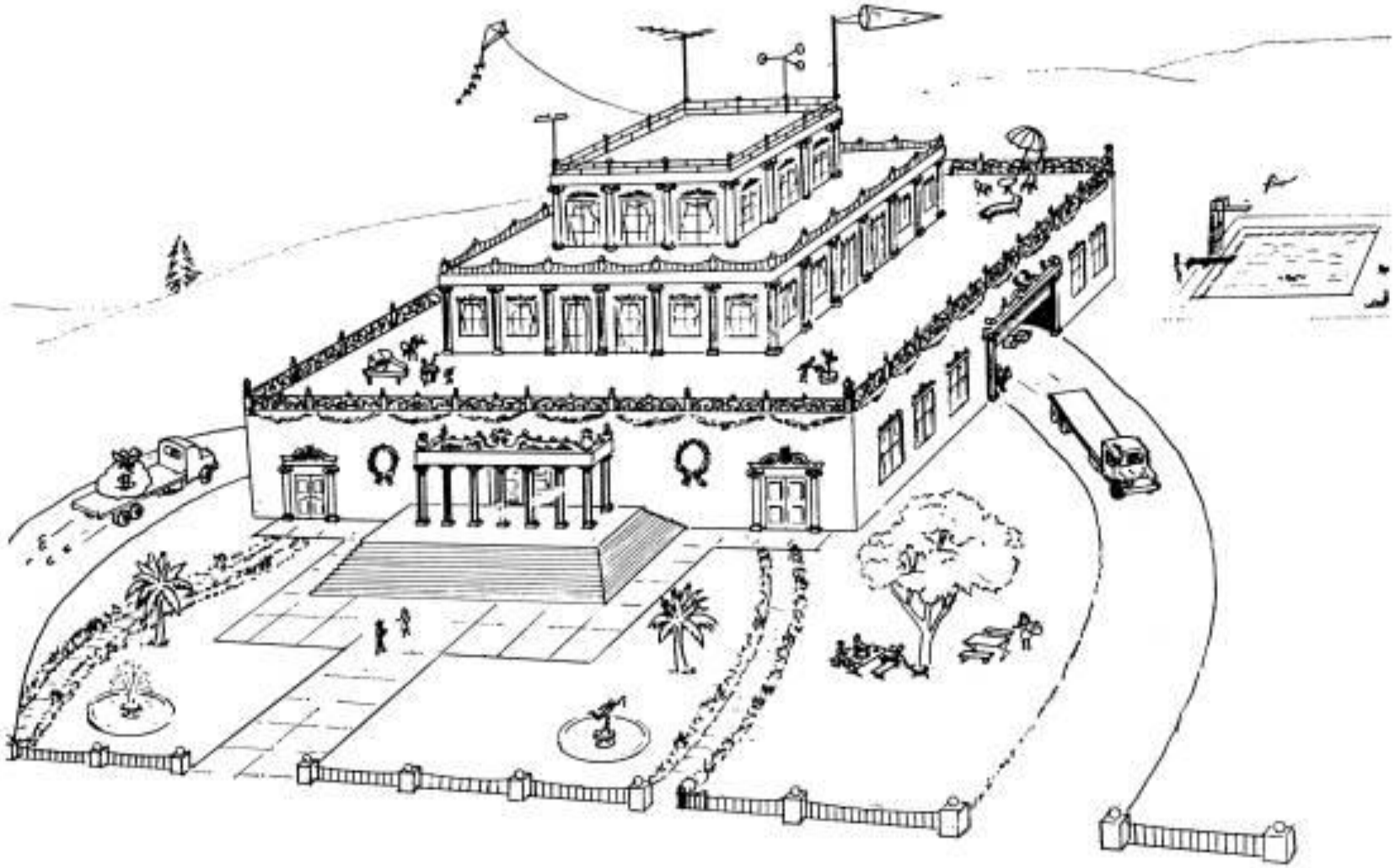
…Eng. mecânico



…operador



…rádio protecção



…agencias de financiamento

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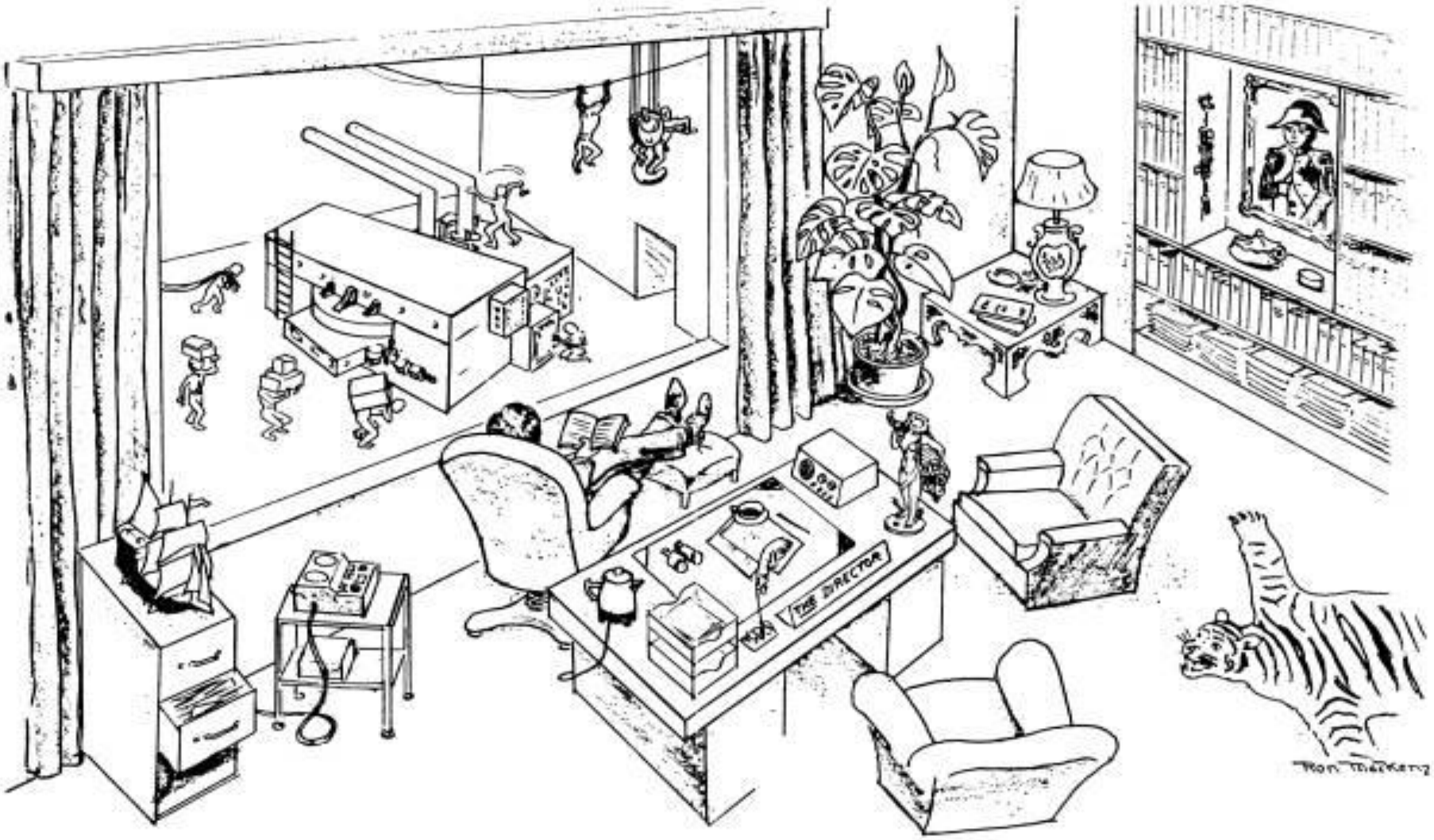
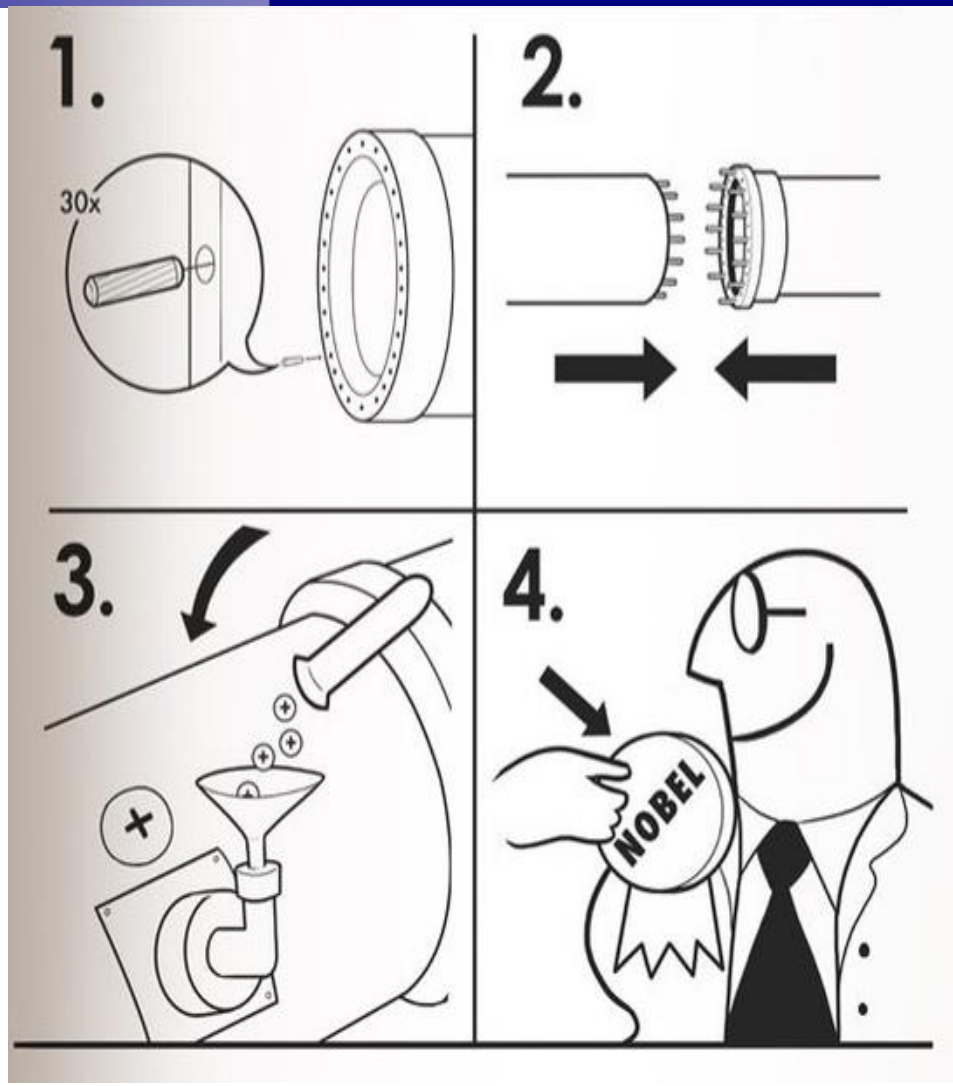


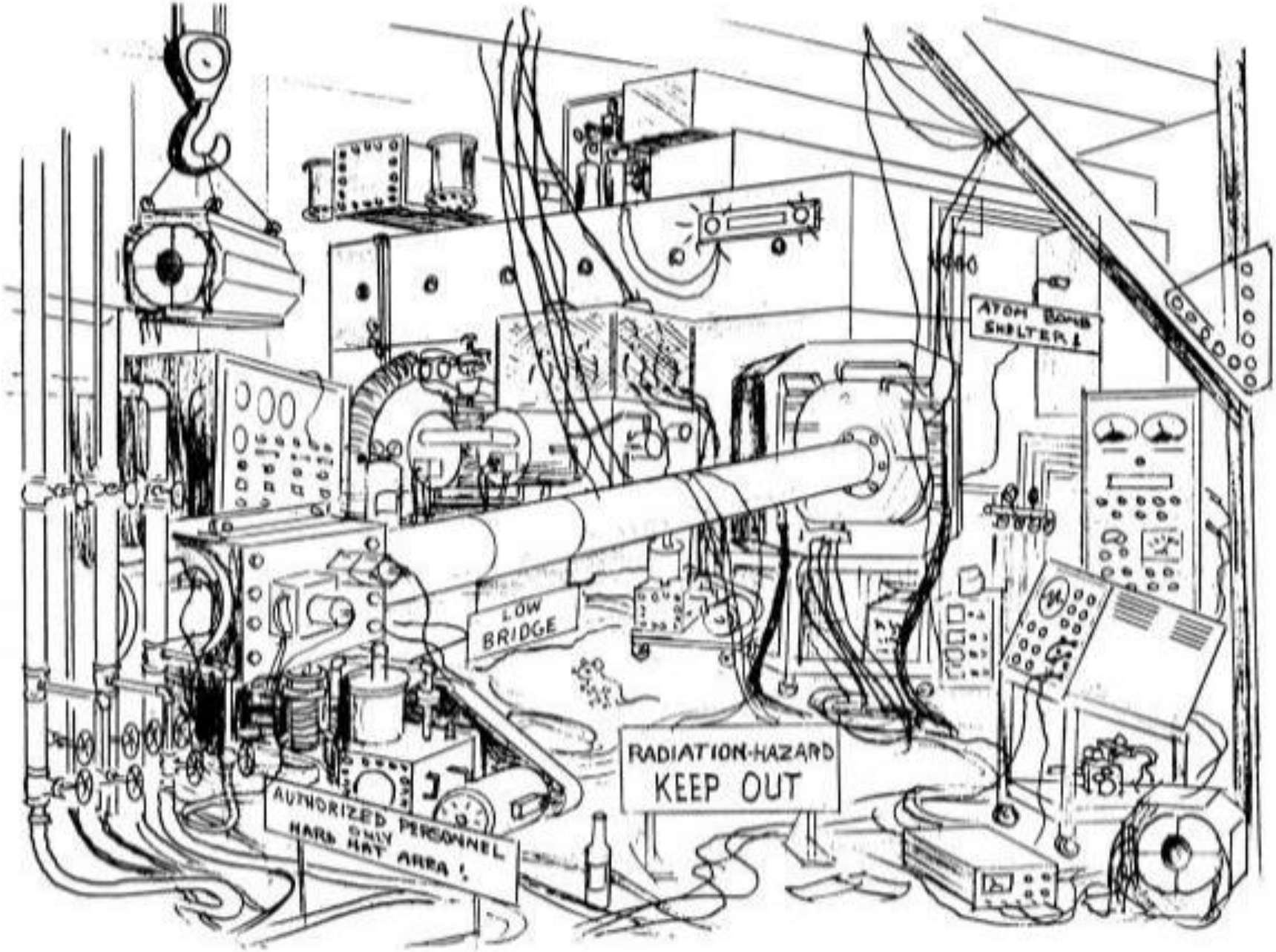
…director geral

XBD9705-02303.TIF

HÄDRÖNN
CJÖLIDDER
60,000x
80,000x
1x
9,000,000x
IKEA
IKEA

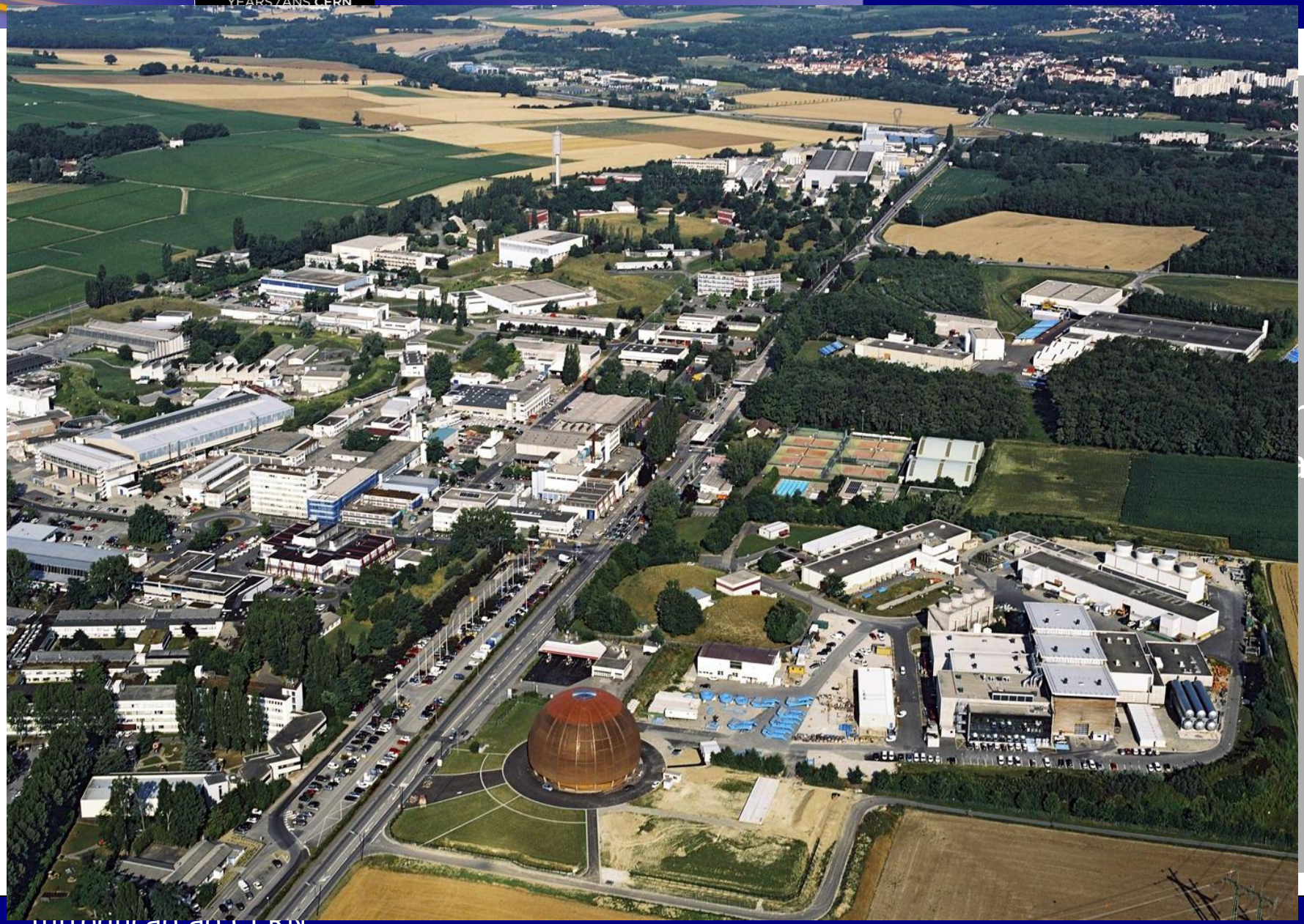

1.
30x
2.
3.
4.
NOBEL

…método IKEA


ATOM BOMB SHELTER
LOW BRIDGE
RADIATION-HAZARD
KEEP OUT
AUTHORIZED PERSONNEL ONLY
HARD HAT AREA!

...por vocês!!

CERN – O(s) Laboratório(s)

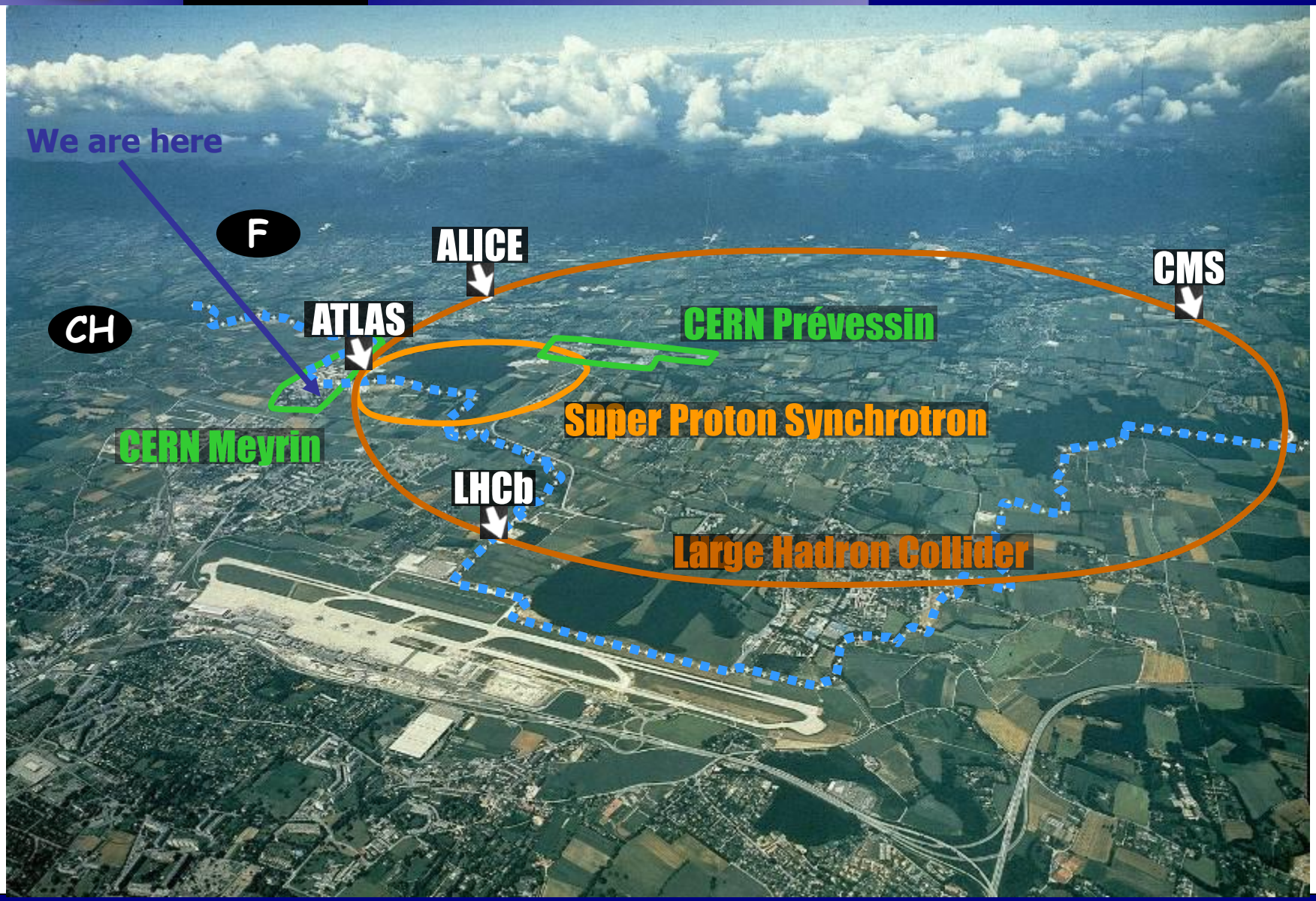


Investigar para descobrir os princípios que mantêm o universo coeso.

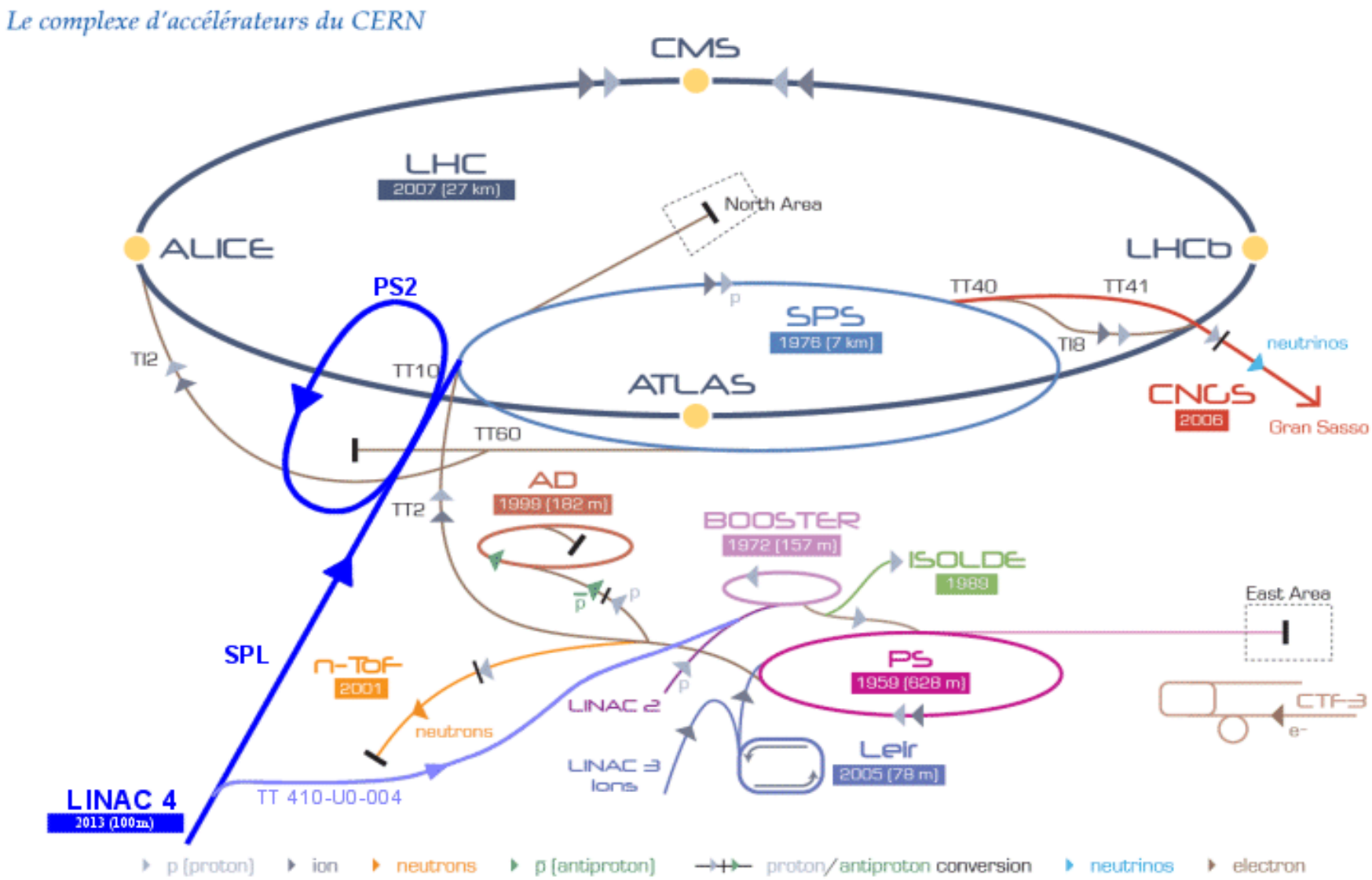
Pesquisa de

- Partículas elementares
- Forças / Interacções entre elas
- Simetrias
- O famoso Higgs…

The physical extents of CERN

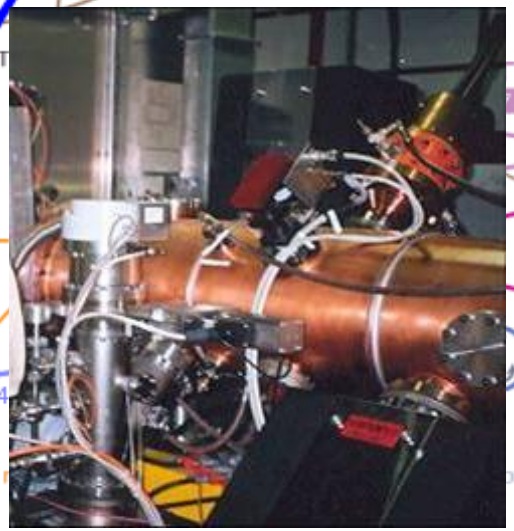


{Aceleradores do CERN}



Gerador de Protões

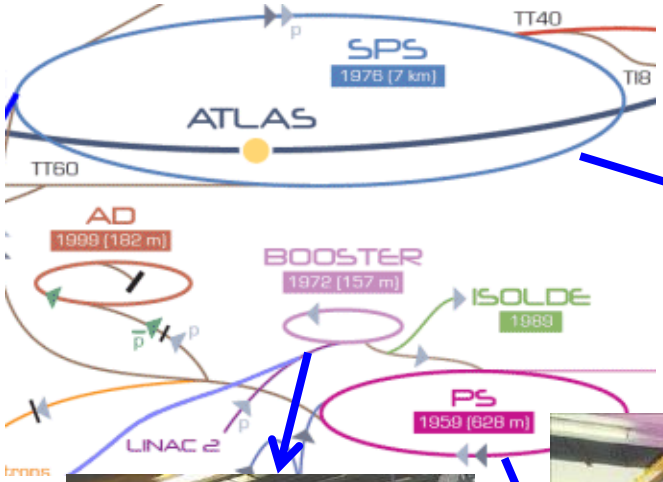
Fonte de Protões

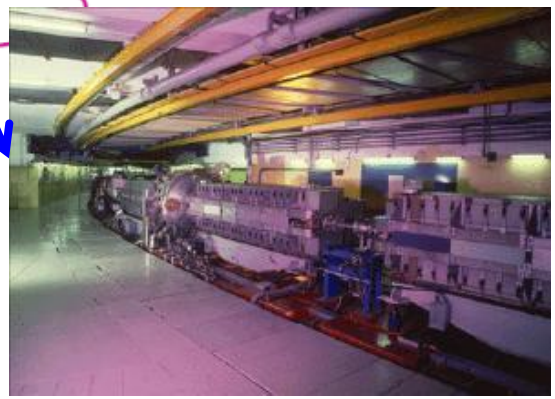


RF quadripolo - 90 KeV

LINAC2 - 50 MeV

Acelerar Partículas



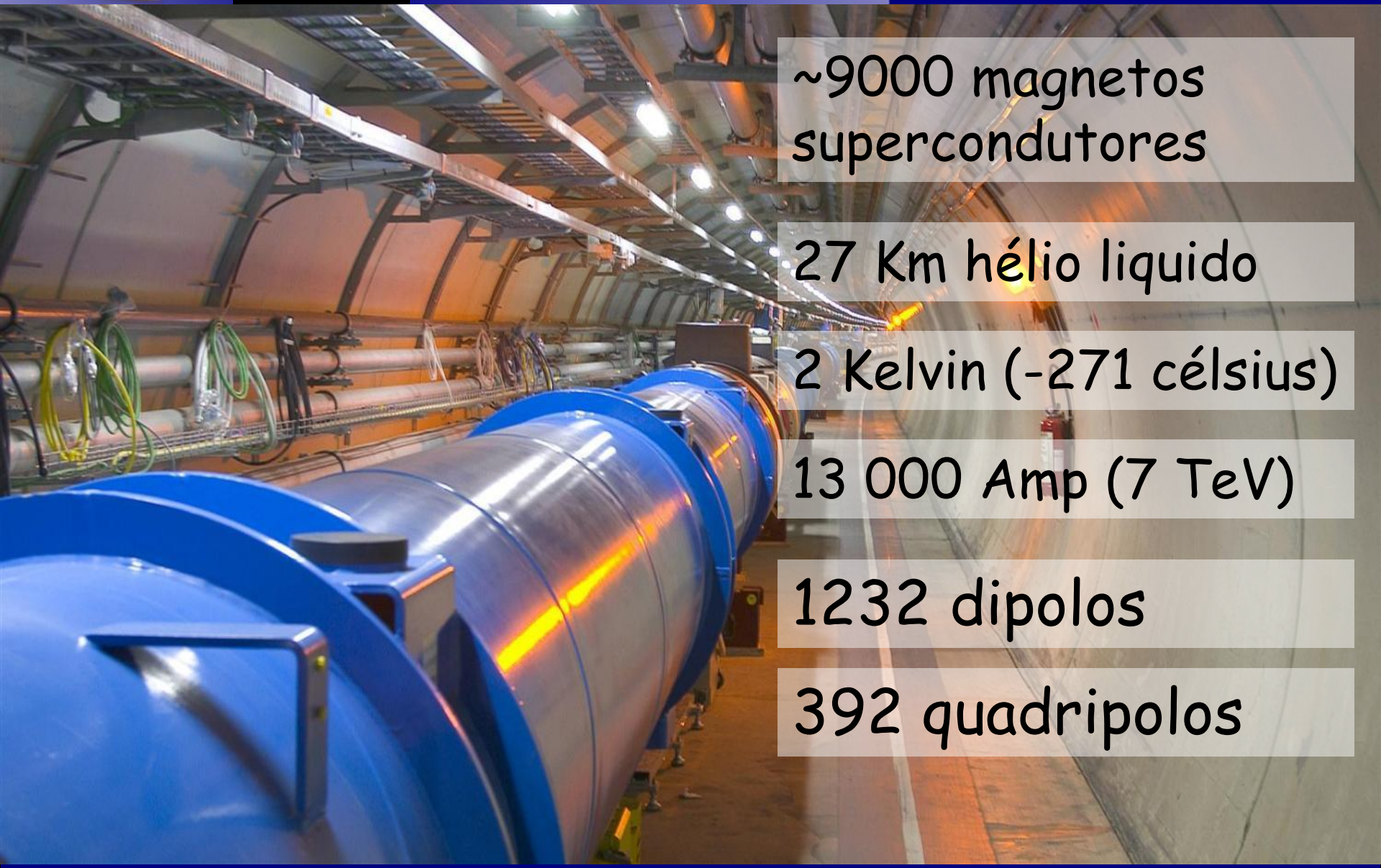


PS Booster 1.4 GeV **Proton Synchrotron 25 GeV** **Super PS 450 GeV**

Entre criar os grupos de protões e leva-los a circular no SPS demora entre
5.86 seconds e 17.86 seconds

No SPS a energia dos protões sobe ate 450GeV e demoram 4.3s a serem injectados no LHC

Túnel LHC



~9000 magnetos supercondutores

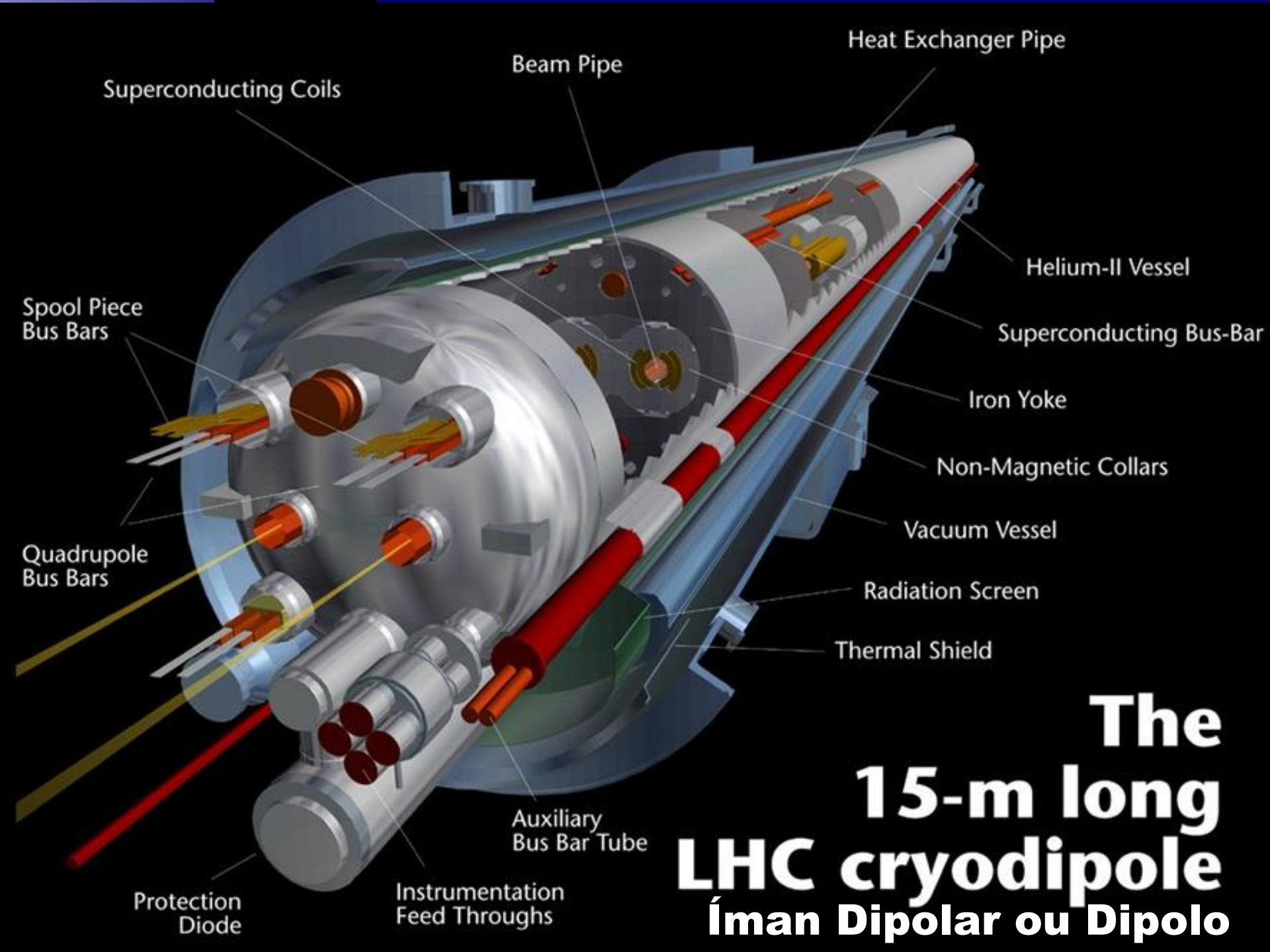
27 Km hélio liquido

2 Kelvin (-271 célsius)

13 000 Amp (7 TeV)

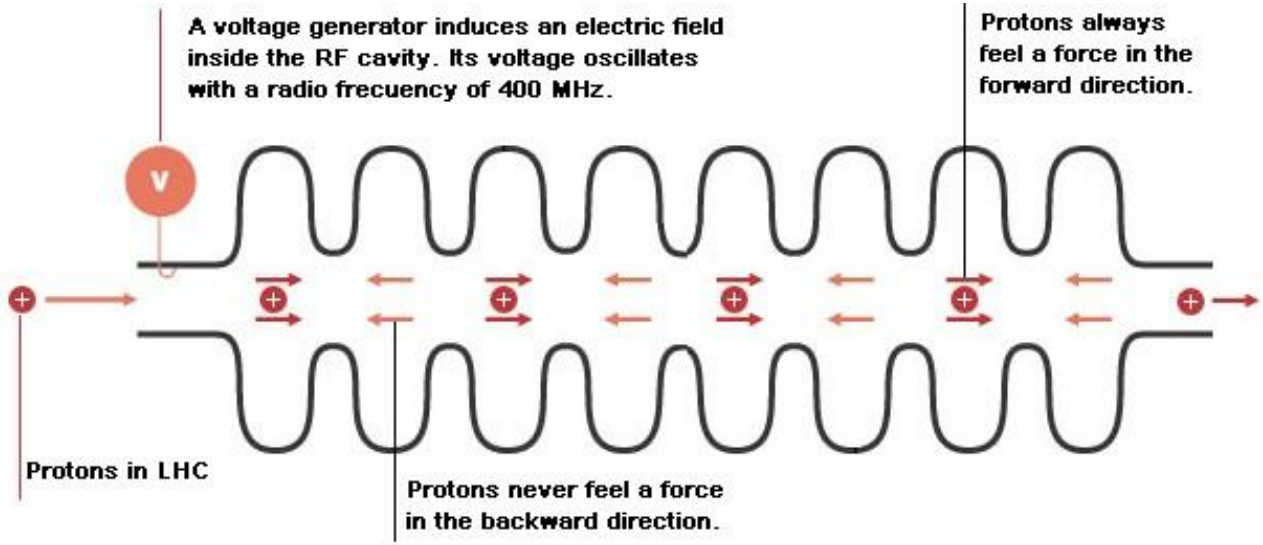
1232 dipolos

392 quadripolos



Íman Dipolar ou Dipolo

Acelerar as partículas

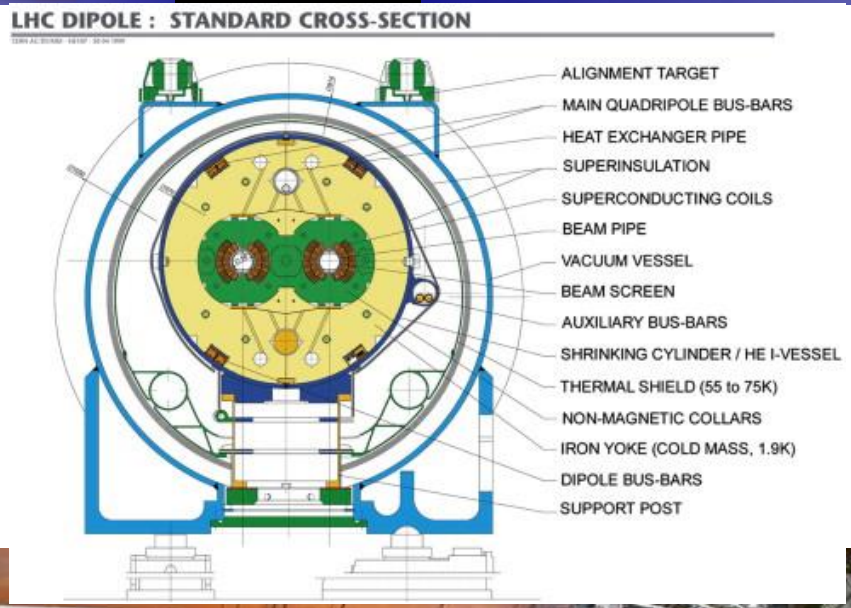


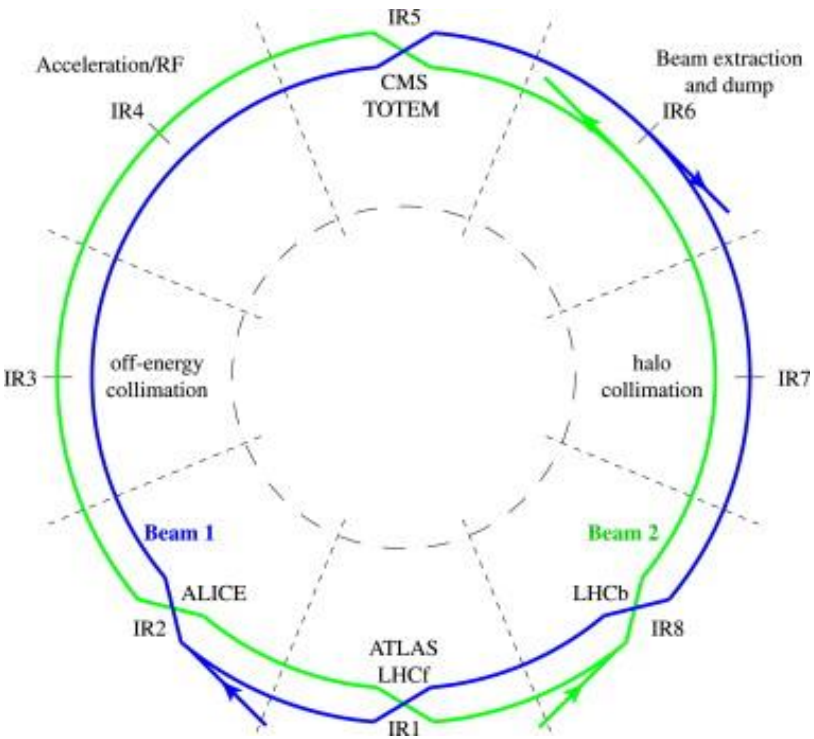
Cada Protão que passa nas cavidades de radiofrequência fica sujeito a:
2 x 8 MV = 16 MV
Recebe, portanto 16 MeV de energia extra

E como cada protao da 11245 voltas ao LHC pro segundo recebe :
(16 MeV/lap) x (11245 laps/s)= $1.8 \cdot 10^5$ MeV/s or 0.18 TeV/s

Acelerar as partículas

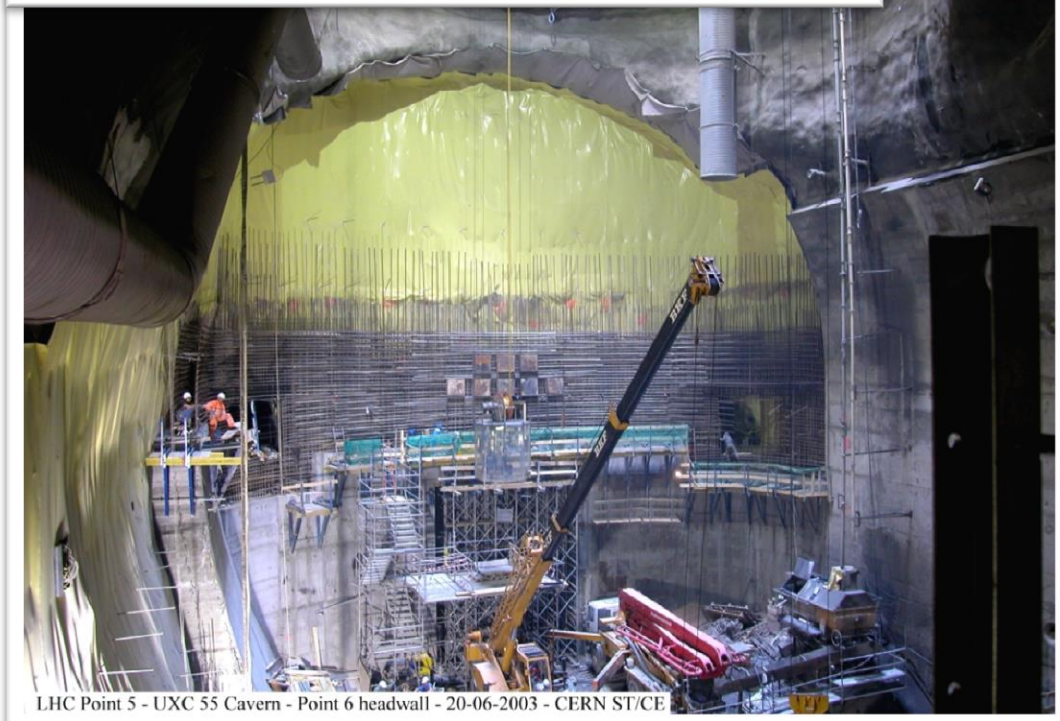
Cavidades RF LHC


LHC DIPOLE : STANDARD CROSS-SECTION
ALIGNMENT TARGET
MAIN QUADRIPOLE BUS-BARS
HEAT EXCHANGER PIPE
SUPERINSULATION
SUPERCONDUCTING COILS
BEAM PIPE
VACUUM VESSEL
BEAM SCREEN
AUXILIARY BUS-BARS
SHRINKING CYLINDER / HE I-VESSEL
THERMAL SHIELD (55 to 75K)
NON-MAGNETIC COLLARS
IRON YOKE (COLD MASS, 1.9K)
DIPOLE BUS-BARS
SUPPORT POST

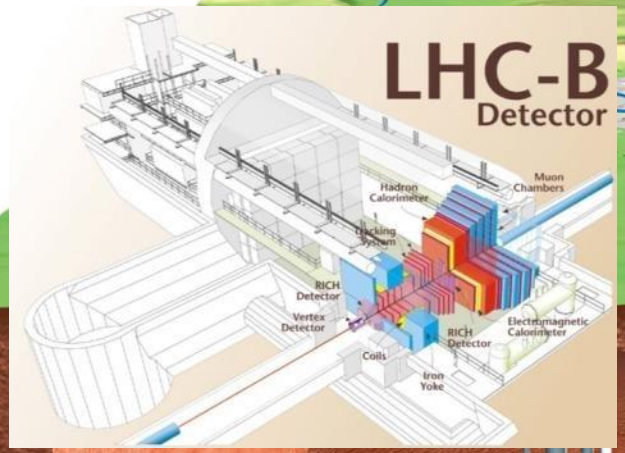

IR5
CMS
TOTEM
Acceleration/RF
IR4
Beam extraction
and dump
IR6
IR3
off-energy
collimation
halo
collimation
IR7
Beam 1
Beam 2
ALICE
IR2
LHCb
IR8
ATLAS
LHCf
IR1

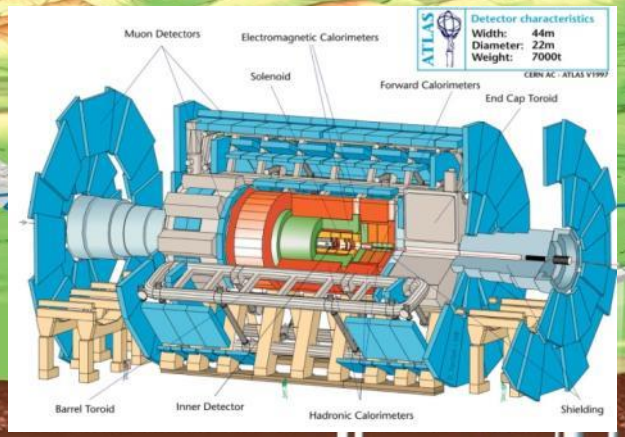
LHC

27 km perímetro
100 m profundidade

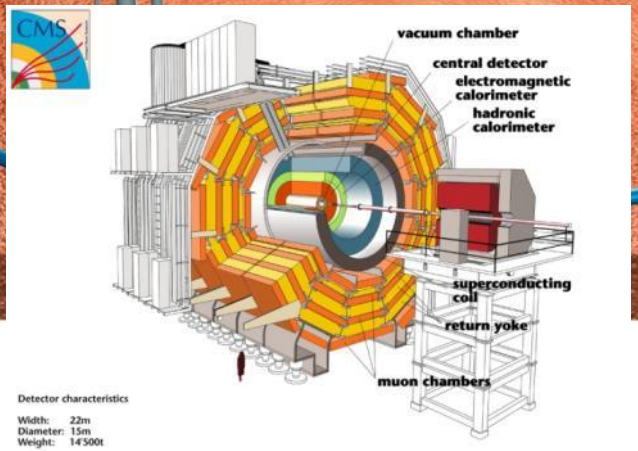


LHC Point 5 - UXC 55 Cavern - Point 6 headwall - 20-06-2003 - CERN ST/CE

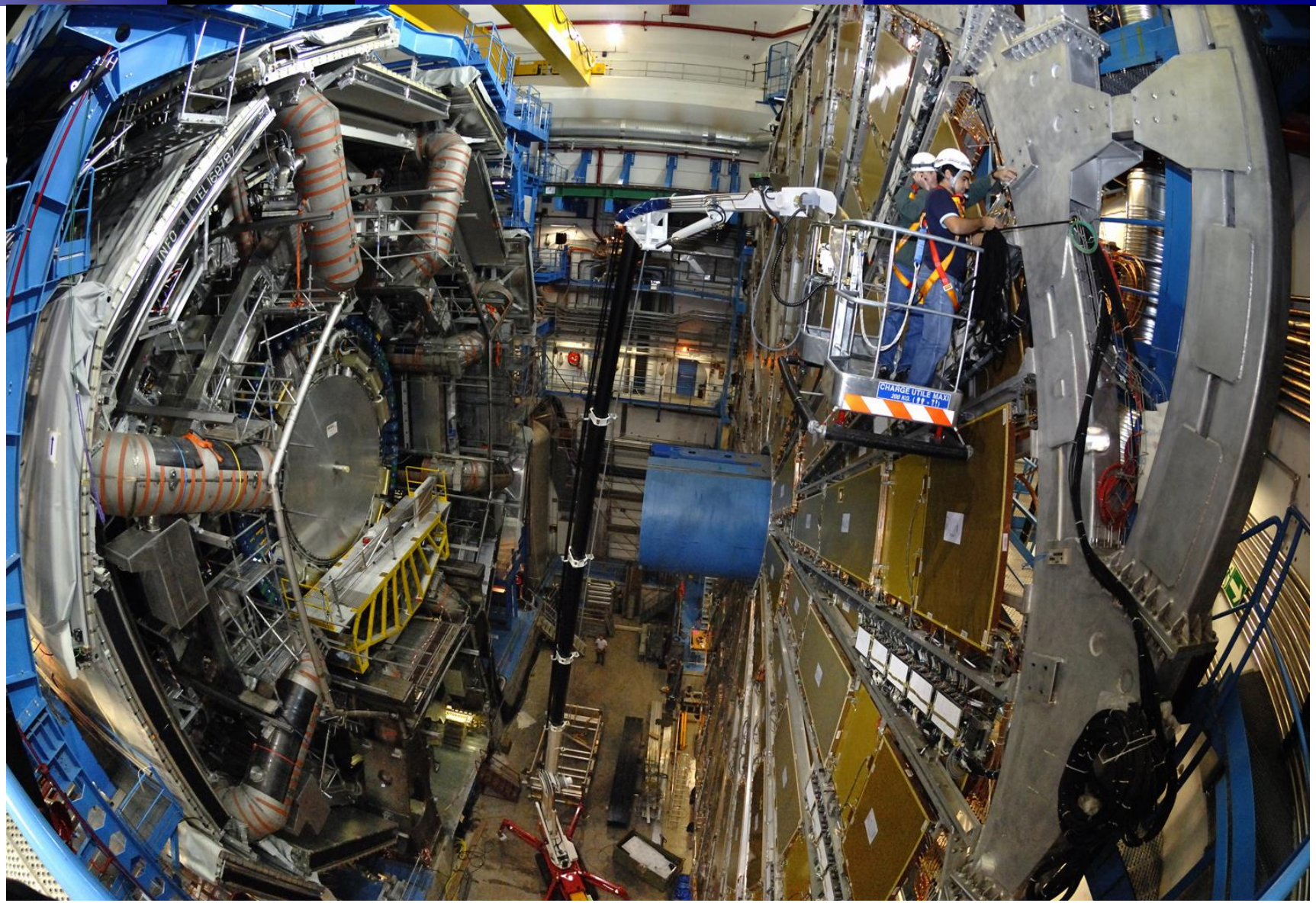

LHC-B
Detector
Hadron Calorimeter
Muon Chambers
Tracking System
RICH Detector
Vertex Detector
RICH Detector
Electromagnetic Calorimeter
Coils
Iron Yoke

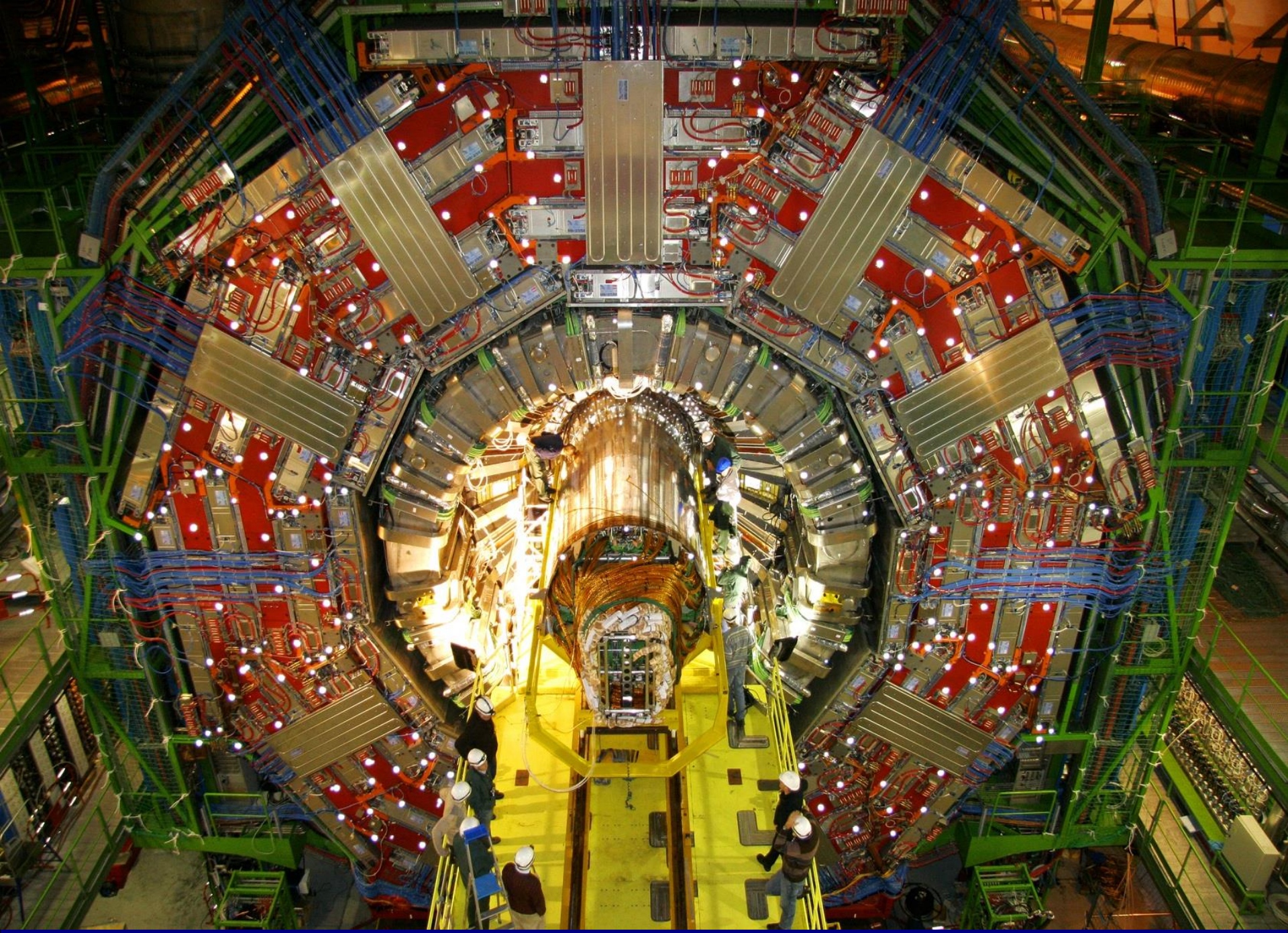

ATLAS
Detector characteristics
Width: 44m
Diameter: 22m
Weight: 7000t
CERN AC - ATLAS V1997
Muon Detectors
Electromagnetic Calorimeters
Solenoid
Forward Calorimeters
End Cap Toroid
Barrel Toroid
Inner Detector
Hadronic Calorimeters
Shielding

ALICE

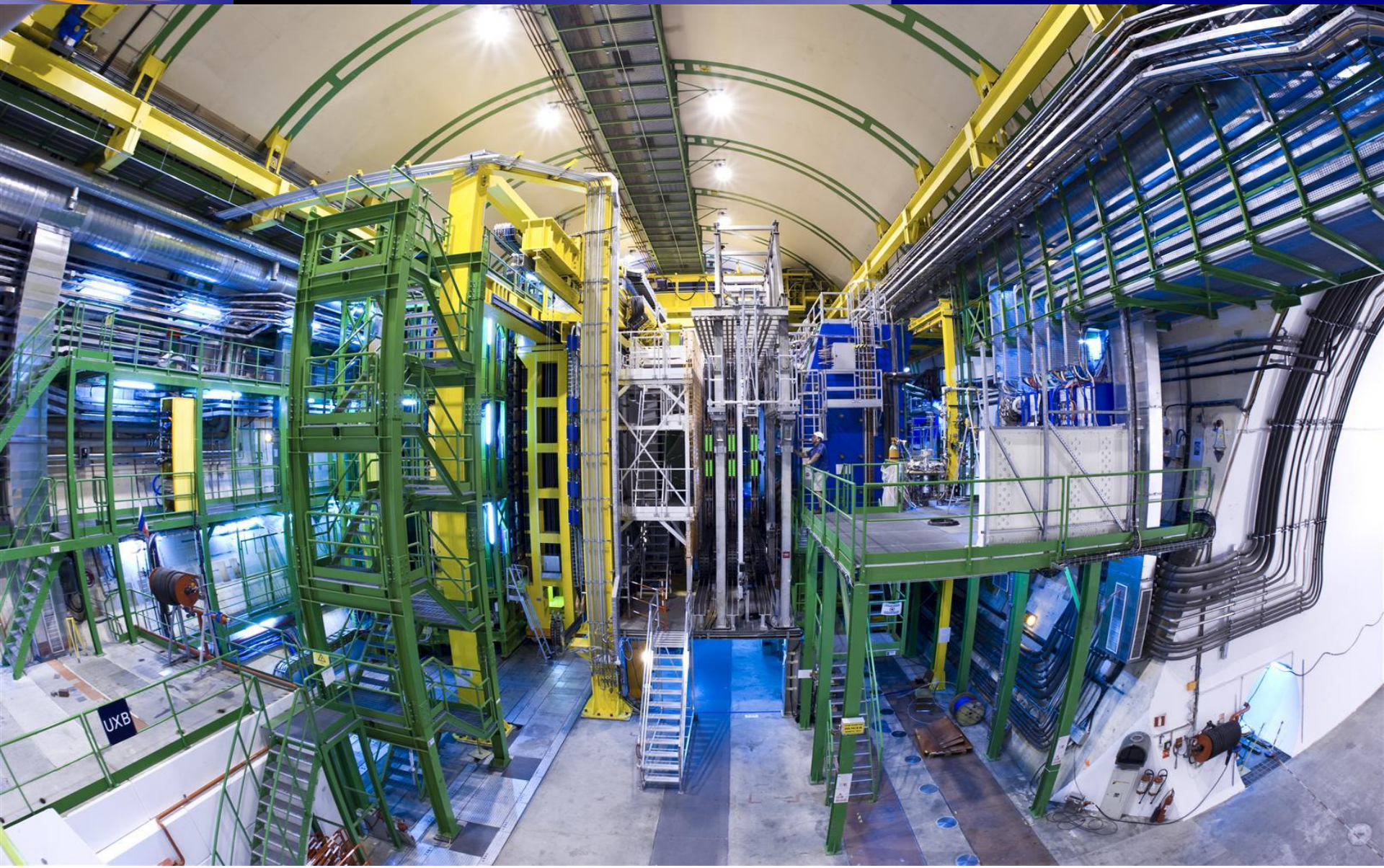

CMS
vacuum chamber
central detector
electromagnetic calorimeter
hadronic calorimeter
superconducting coil
return yoke
muon chambers
Detector characteristics
Width: 22m
Diameter: 15m
Weight: 14'500t

ATLAS Experiment

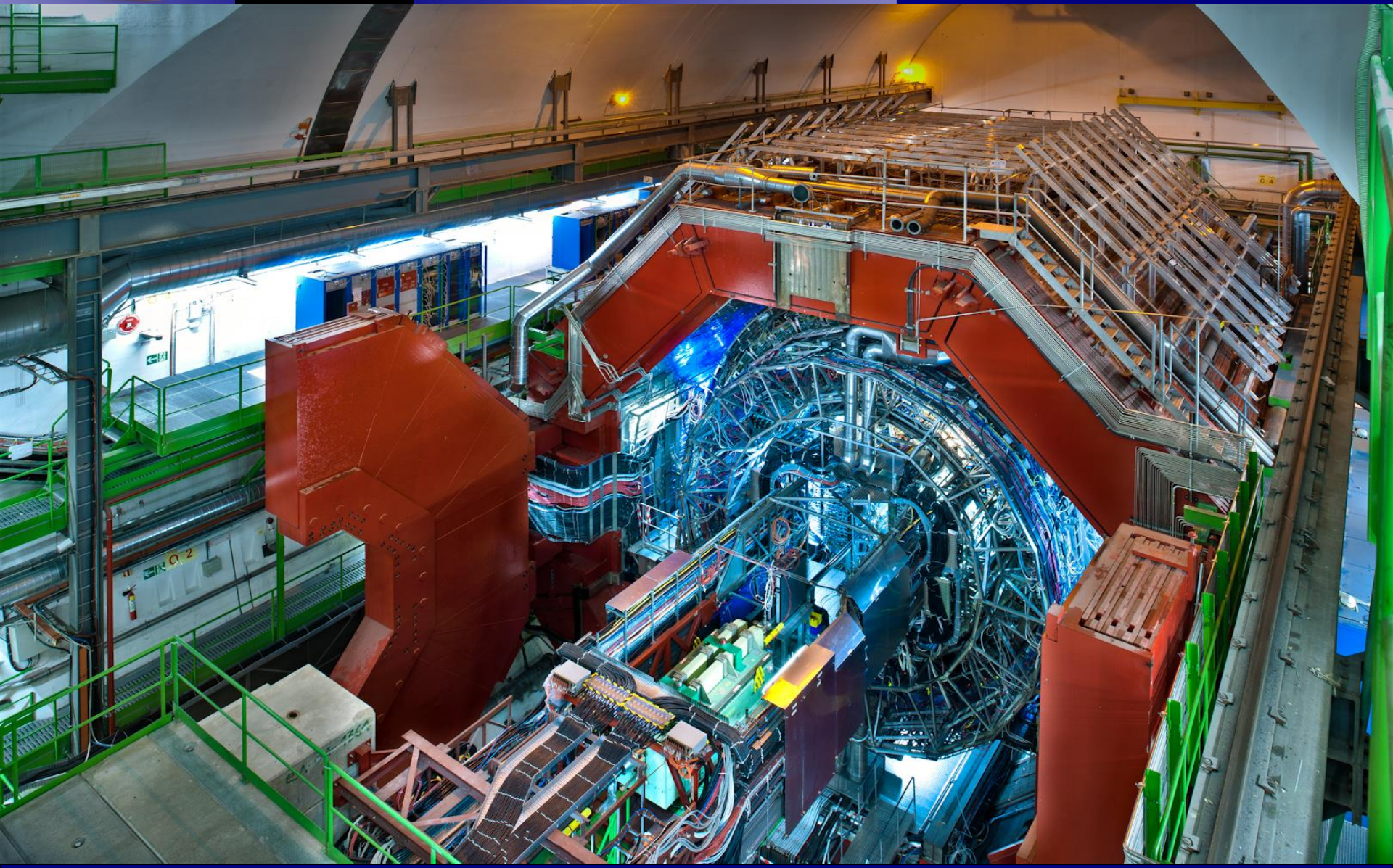




LHCb Experiment

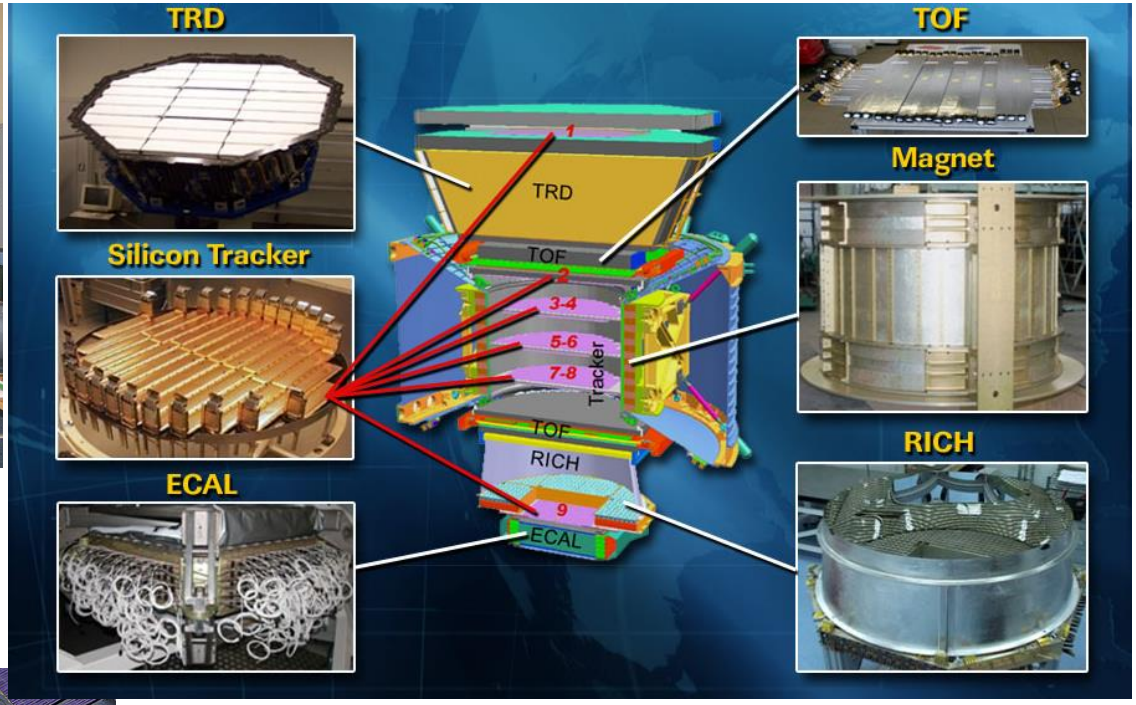


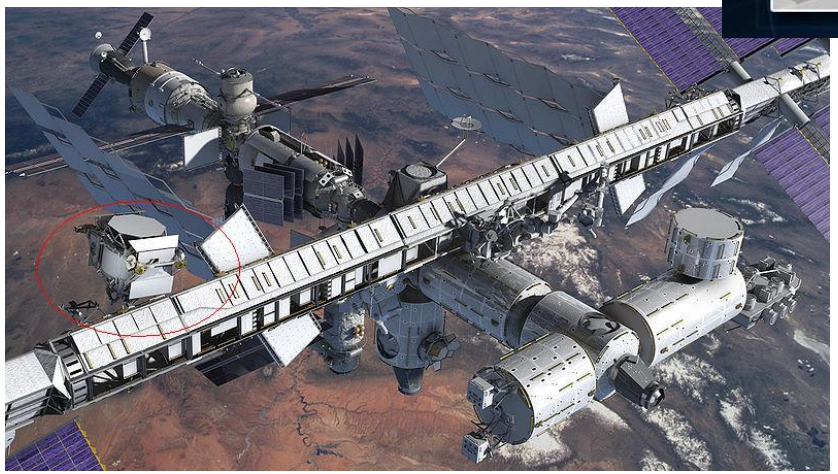
ALICE Experiment



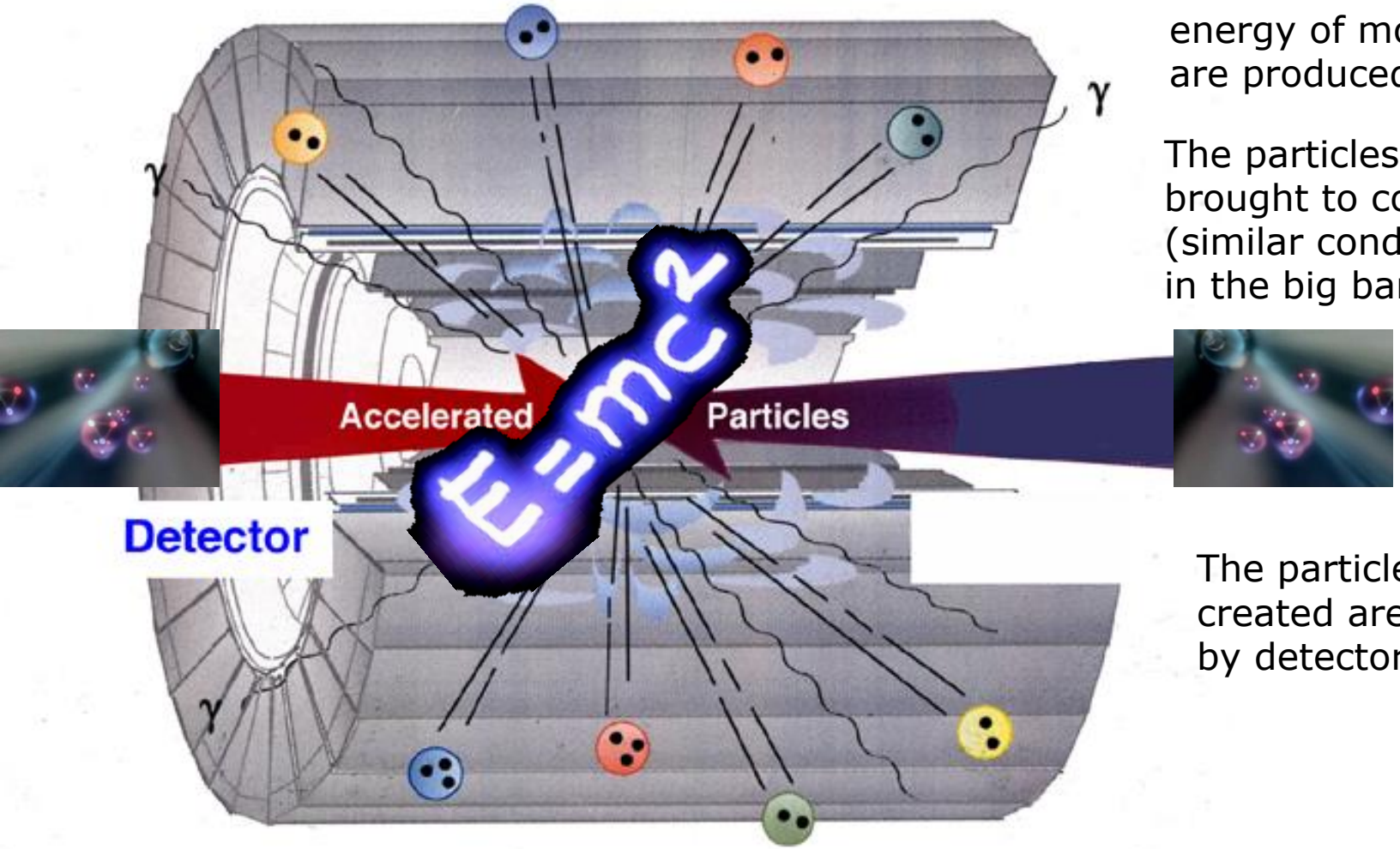
Alpha Magnetic Spectrometer, AMS-02

AMS Centro de Operações
@CERN Prevessin





Detectores em Física de Partículas



Particles with very high energy of movement are produced.

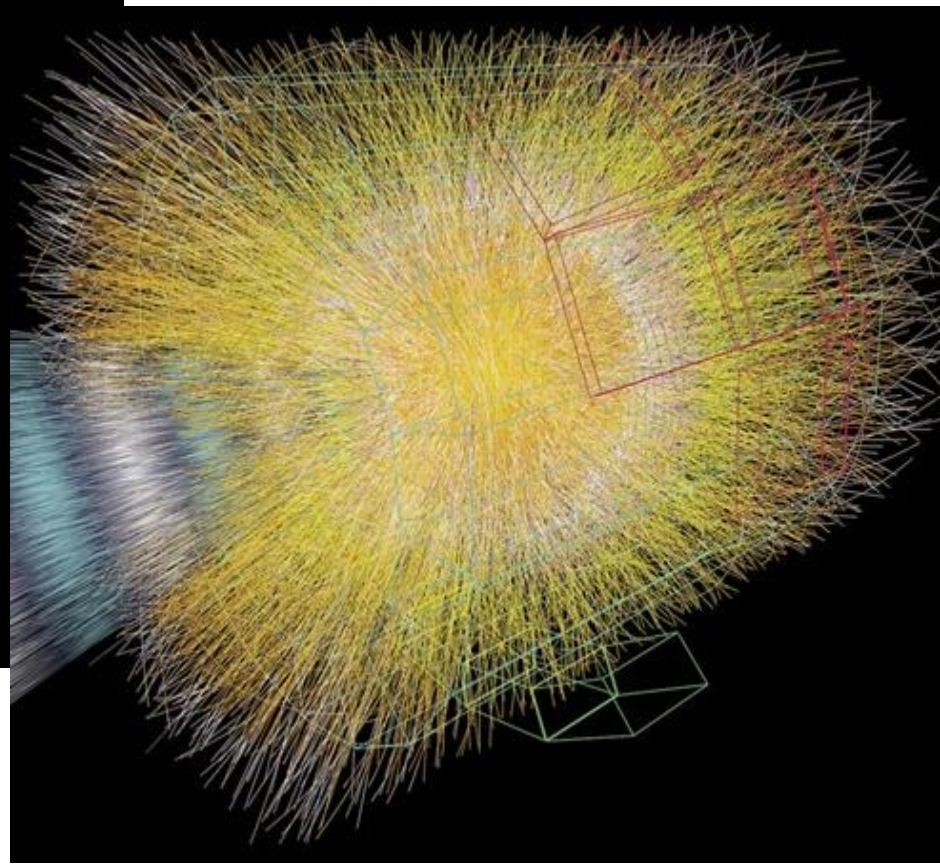
The particles are brought to collision (similar conditions as in the big bang).

The particles that are created are recorded by detectors.

Colisões : passado vs. futuro

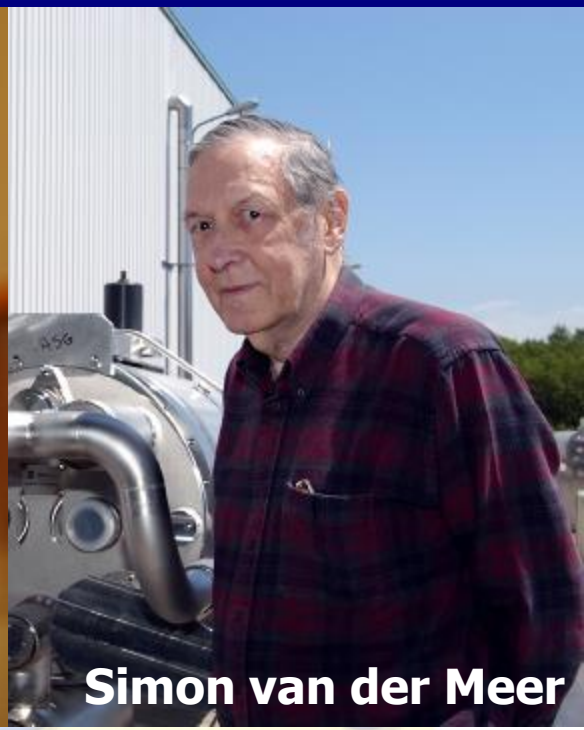
Experiencia Anterior
(DELPHI, LEP)

LHC
(ALICE)



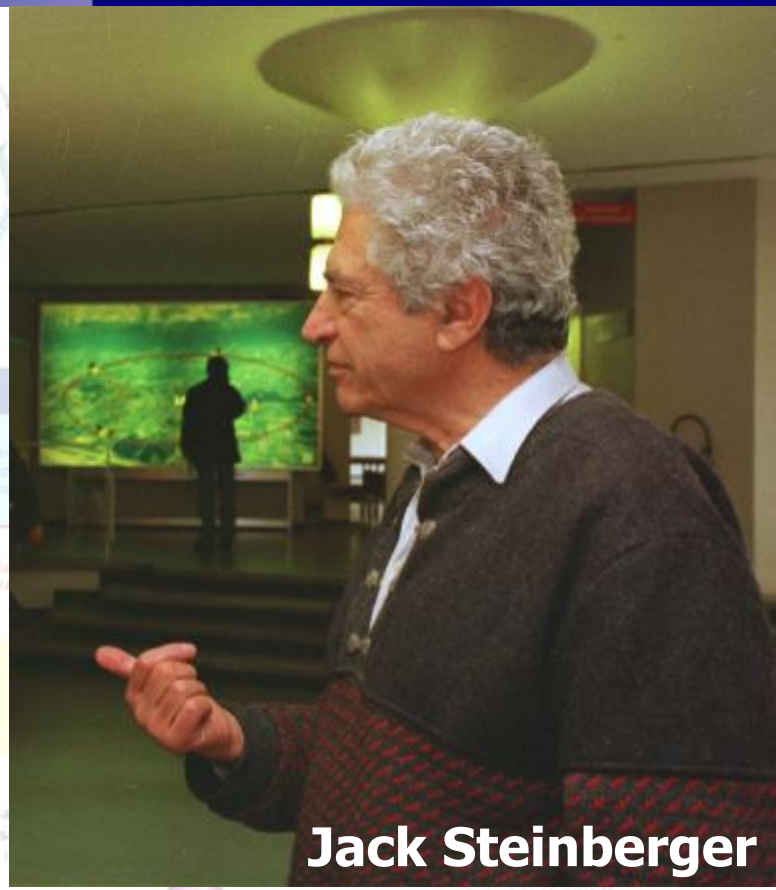
The GRID: a possible solution to CERN computing needs

Nobel prize **1984**: CERN



"for their decisive contributions to the large project, which led to the discovery of the field particles W and Z, communicators of weak interaction"

Nobel prize **1988**: CERN



"for the neutrino beam method and the demonstration of the doublet structure of the leptons through the discovery of the muon neutrino"

Nobel prize **1992**: CERN

Como não podemos ir ao shopping buscar os detectores que precisamos...

Inventamo-los!

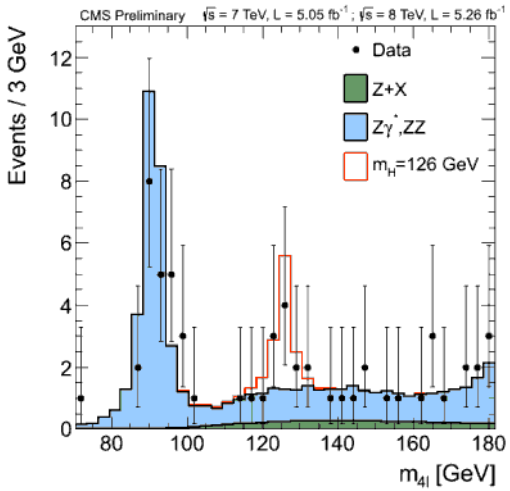
"for his invention and development of particle detectors, in particular the multiwire proportional chamber"

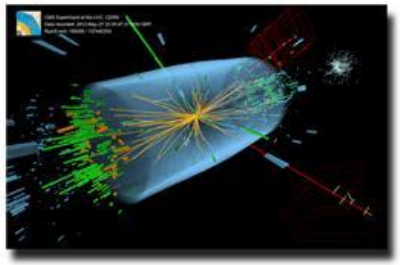
Qual o próximo Nobel?

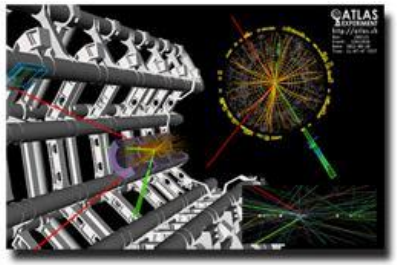
Georges Charpak

Nobel prize **2013**: CERN

Peter Higgs
&
Francois Englert

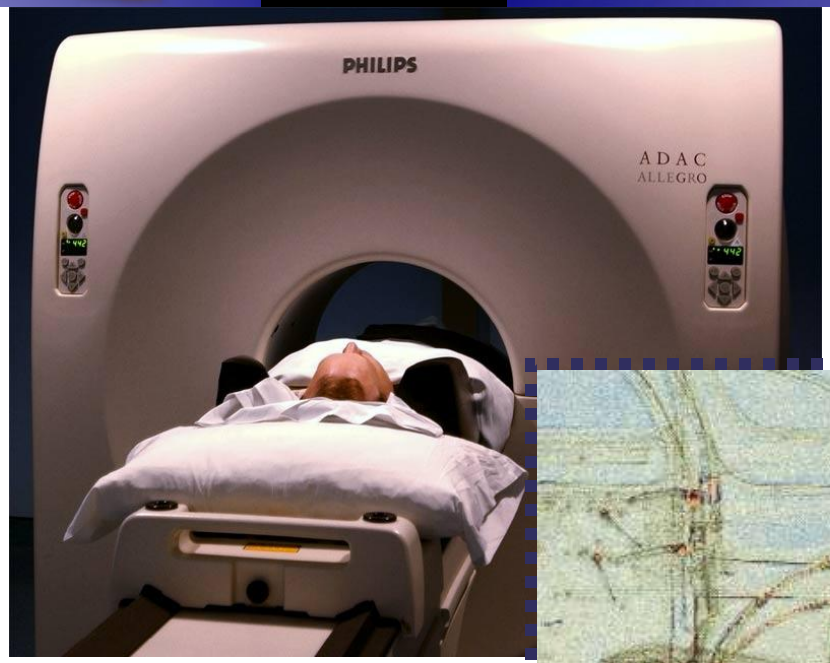


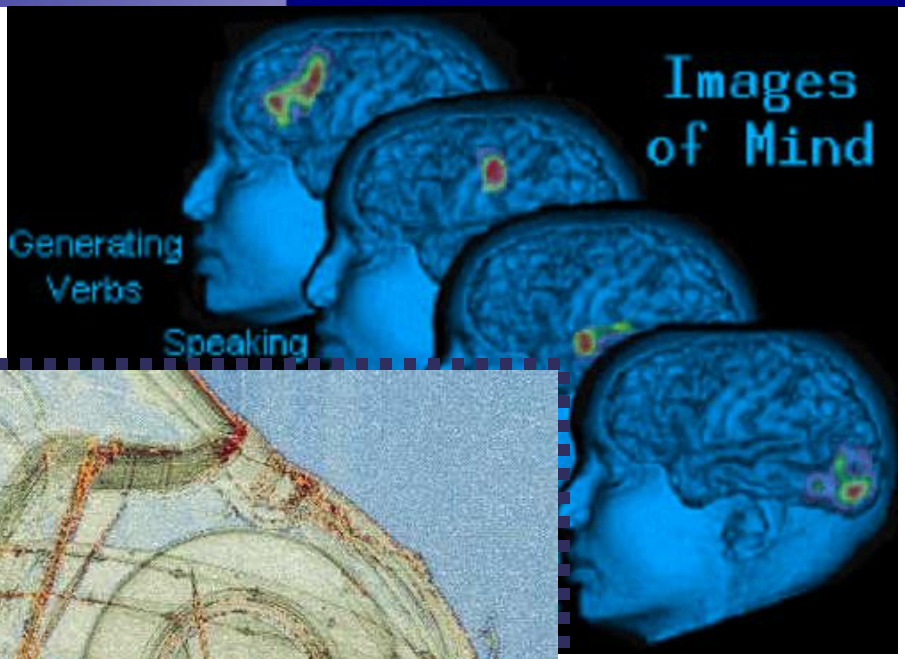


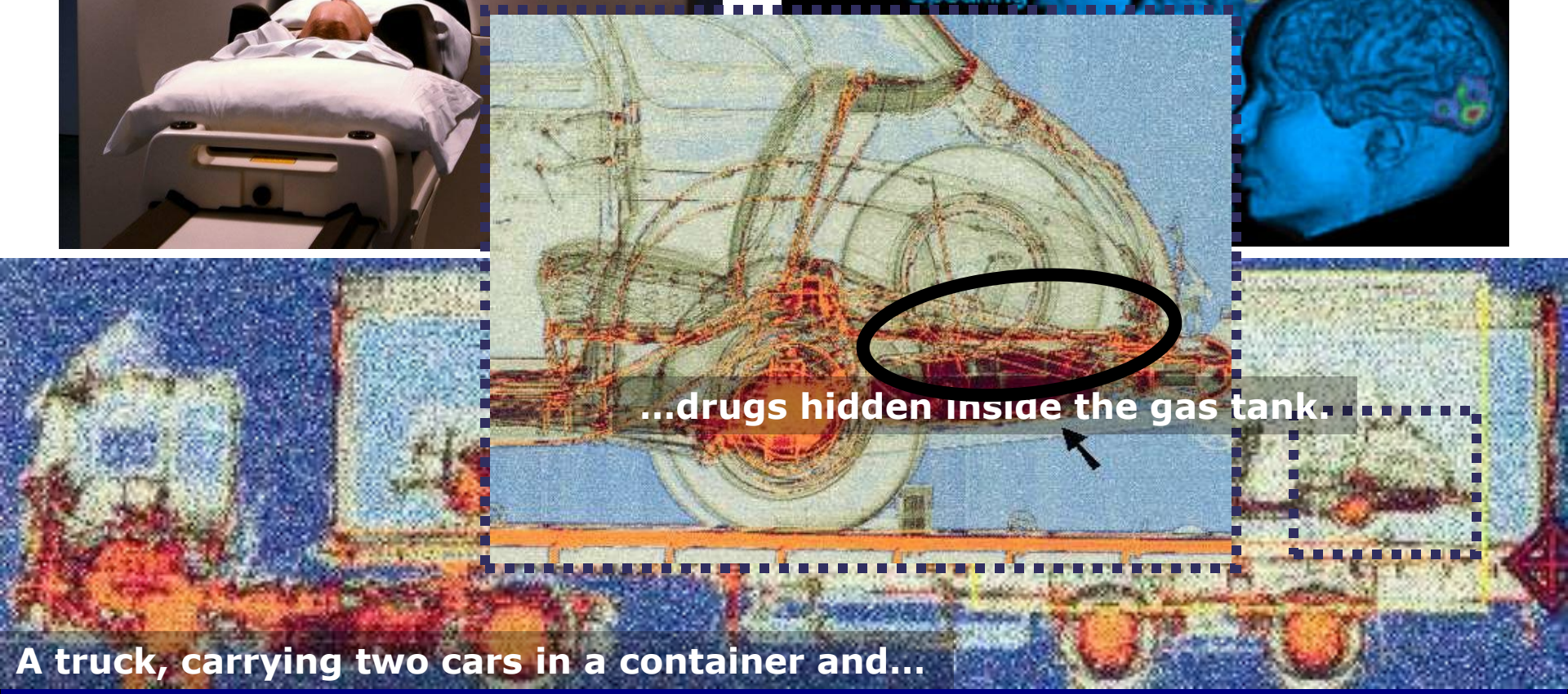


*" "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the **ATLAS** and **CMS** experiments at **CERN's Large Hadron Collider**""*

Outras aplicações







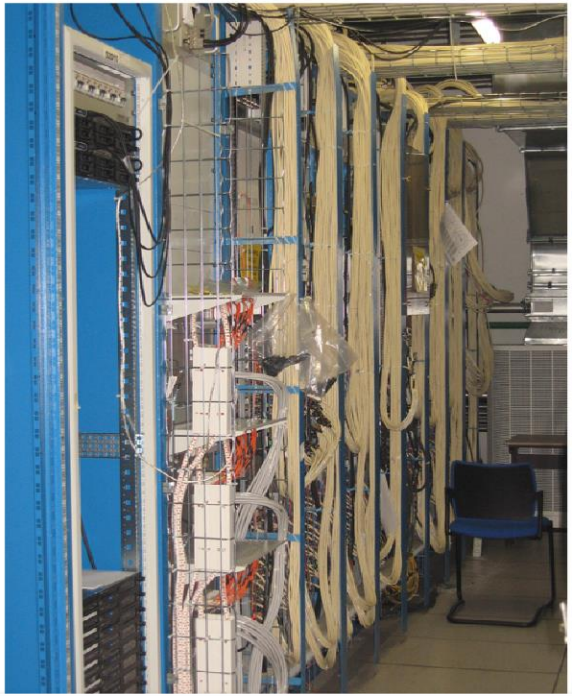
World Wide Web, GRID, Computing…

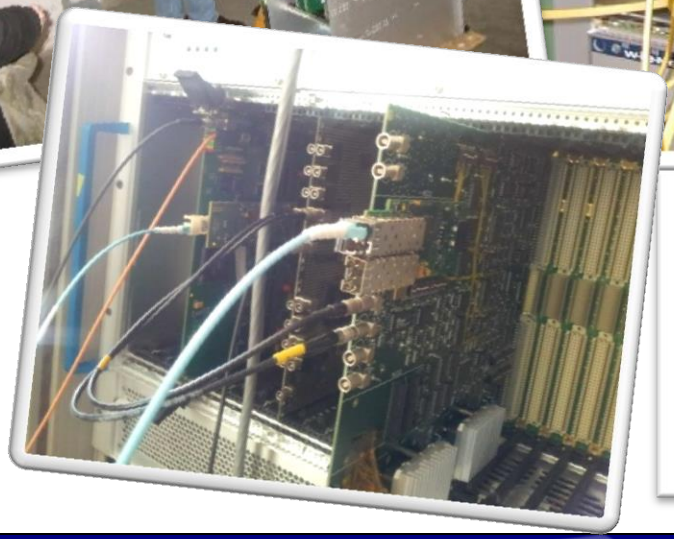
Tim Berners-Lee
father of the WWW

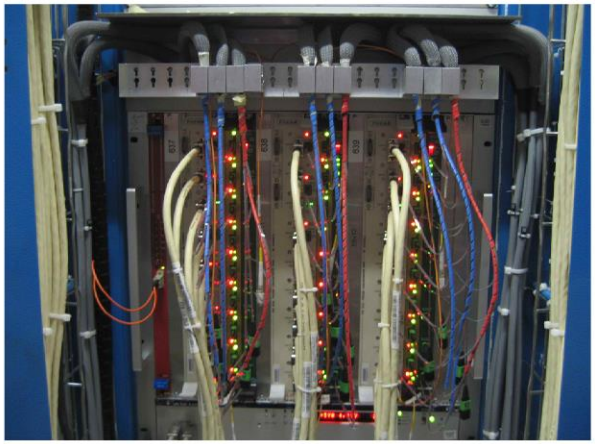
www.cern.ch

…and into the future.

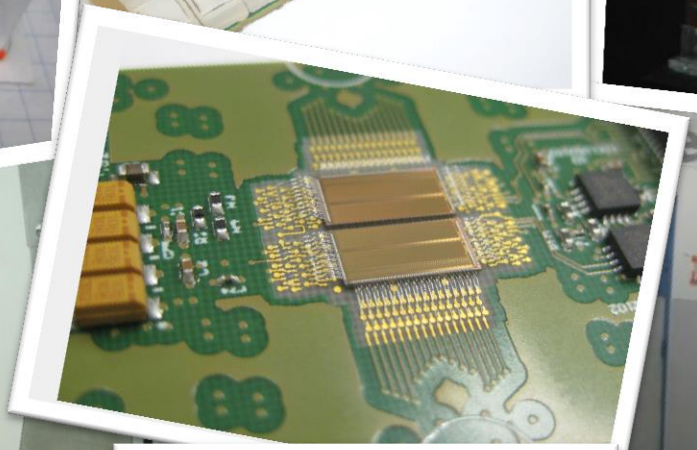
“home made” (CMS, PET, MT)







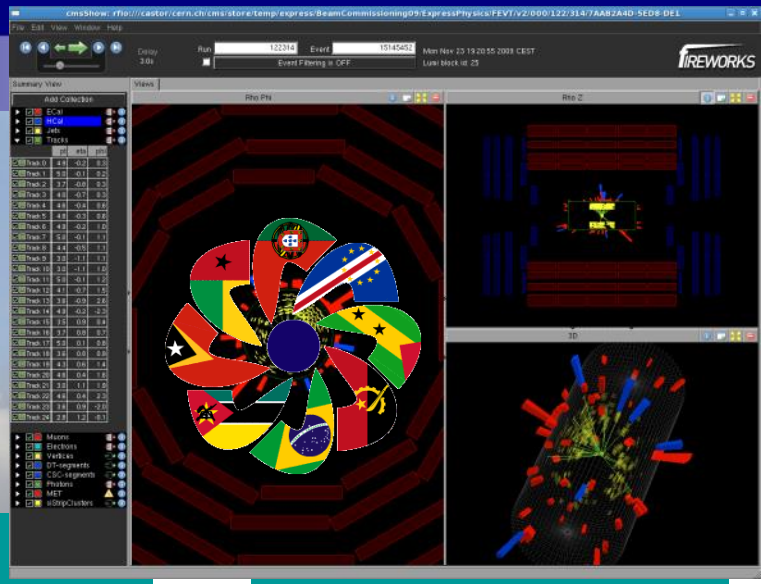
"home made" (CMS, PET, MT)



Globe of Innovation

60 YEARS/ANS CERN

Obrigado e Uma Boa Escola!



Colaboração Internacional

Pesquisa Física Fundamental

Formação

Tecnologia

Facebook : Escola de Professores no CERN